machine translation of Ref. 3

CLAIMS

[Claim(s)]

[Claim 1]It is the method characterized by comprising the following of routing information on a packet between two move hosts combined with an ad hoc network which comprises two or more move hosts who do not have a fixed position although it has a peculiar network address, respectively, and he is each move host.
A stage of memorizing a routing table including ″distance″ defined as a hop number from a sauce move host to a destination moving host.
A stage which announces a course publicly when the move host does periodically the simultaneous transmissive communication of the routing table memorized by each move host.
A stage which tags an entry of each routing table with a time stamp emitted from a destination moving host.
A stage which updates a routing table memorized by move host for every destination moving host based on simultaneous transmissive communication received from other move hosts.
A stage which carries out retransmission of the new routing information which each move host received from a contiguity move host.
A stage which chooses a course for transmitting information on a packet from a sauce move host as a course which has the best ″distance″ about a desired destination moving host.

[Claim 2]A routing method according to claim 1 characterized by performing routing by a link layer of an ad hoc network according to a network standard in which an ad hoc network contains a network layer and a link layer.
[Claim 3]A shorter distance or an infinite distance is defined as a course which it has by the new course, and it an infinite distance, Express a destroyed link, namely, it becomes impossible for a specific address to reach, Therefore, it means that attainment of all the addresses of others depending on an address in which this new attainment is impossible becomes impossible in itself, A routing method according to claim 1, wherein the immediate execute of said stage which carries out retransmission of the new routing information received from a contiguity move host is done by move host at the time of reception of new routing information.
[Claim 4]By determining average stable waiting time of a stage of holding data about frequency where a course memorized by said routing table changes, and a course memorized by said routing table, A stage which measures the stability of a course, and a stage of memorizing stable waiting time of a measured course on a stable waiting time table, A routing method according to claim 1 which accesses on a stable waiting time table before a public announcement stage, delays a public announcement of a course which may change soon, and includes further a stage which lessens change of information in said routing table by that cause.
[Claim 5]A routing method according to claim 4 which includes further a stage of performing weighting in course stable waiting time measured by counting the newest measured value of stable waiting time of a specific course which has a bigger load factor than old measured value.
[Claim 6]A stage where an ad hoc network memorizes routing information to said routing table further based on a move host's network layer address, By determining average stable waiting time of a stage of holding data about frequency where a course memorized by said routing table changes, and a course

memorized by said routing table, A stage which measures the stability of a course, and a stage of memorizing stable waiting time of a measured course on a stable waiting time table, A routing method according to claim 1 which accesses on a stable waiting time table before a public announcement stage, delays a public announcement of a course which may change soon, and includes further a stage which lessens change of information in said routing table by that cause.

[Claim 7]A stage of memorizing routing information to said routing table based on a move host's link layer address, By determining average stable waiting time of a stage of holding data about frequency where a course memorized by said routing table changes, and a course memorized by said routing table, A stage which measures the stability of a course, and a stage of memorizing stable waiting time of a measured course on a stable waiting time table, A routing method according to claim 1 which accesses on a stable waiting time table before a public announcement stage, delays a public announcement of a course which may change soon, and includes further a stage which lessens change of information in said routing table by that cause.

[Claim 8]A routing method according to claim 1 which includes further a stage which pursues network layer protocol availability data for every address.

[Claim 9]It comprises two or more move hosts characterized by comprising the following who do not have a fixed position although it has a peculiar network address, respectively, Including a network layer and a link layer, it is how to route information on a packet between two move hosts combined with an ad hoc network according to a network standard, and he is each move host.

A stage of memorizing a routing table including "distance" defined as a hop number from a sauce move host to a destination moving host.

A stage which announces a course publicly when the move host does periodically the simultaneous transmissive communication of the routing table memorized by each move host.

A stage which tags an entry of each routing table with a time stamp emitted from a destination moving host.

It is a stage which updates a routing table memorized by move host for every move host based on simultaneous transmissive communication received from other move hosts, Said updating is limited to the new course defined as a course which has a better distance or an infinite distance, An updating stage meaning attainment of all the addresses of others which an infinite distance expresses a destructive link, namely, it becomes impossible for a specific address to reach therefore, and are dependent on an address in which this new attainment is impossible becoming impossible in itself.

A retransmission stage which is a stage where each move host does retransmission of the new routing information received from a contiguity move host, and will be immediately performed if a move host receives new routing information.

A stage which chooses from a sauce move host a course which transmits information on a packet as a course which has the shortest "distance" about a desired destination moving host.

[Claim 10]A routing method comprising according to claim 9:

A stage of holding data about frequency where a course memorized by said routing table changes.

A stage which measures the stability of a course by determining average stable waiting time of a course memorized by said routing table.

A stage of memorizing stable waiting time of a measured course on a stable waiting time table.

A stage which accesses on a stable waiting time table before a public announcement stage, delays a public announcement of a course which may change soon, and lessens change of information in said routing table by that cause.

[Claim 11]A routing method according to claim 10 which includes further a stage of performing weighting in course stable waiting time measured by counting the newest measured value of stable waiting time of a specific route which has a bigger load factor than an old phenomenon.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]Generally this invention relates to details more about a wireless data communication system at link layer routing for move computers.
[0002]
[Description of the Prior Art]The network protocol of various many is defined. For example, the International Business Machines (IBM) condominium ration established the System Network Architecture (SNA) which defines the specific protocol which enables the IBM computer and communication for the compatible computers. International Organization for Standardization (ISO) is the international organization which announced the standard for the open systems interconnection (OSI) architecture. The Defense Data Network (DDN) standard has established the standard for Internet Protocol (IP) which supports the interconnection of a local area network (LAN). IP defined the service provided for a user and specifies the mechanism required in order to support those services. This standard defined service required for an underlying protocol layer again, described the interface of a higher rank and a low rank, and has described the outline of execution environment service required for operation.
[0003]A data link control protocol (TCP) is an offer transport protocol about the data communications between terminals with the high reliability of a connection basis in packet-switching computer LAN and an internetwork. IP and TCP are indispensable in order to use all the packet switching networks of the U.S. Department of Defense (DoD) which has a possibility of crossing the boundary of a network or a subnetwork, and connecting, or using connectivity. In such a network used for internetworking, network elements, such as a host, a front end, and a gateway, must carry out TCP/IP.
[0004]IP is designed carry out interconnection of the packet switched communication LAN, and constitute an internetwork. IP transmits the block of the data called the Internet diagram from sauce to an address via the Internet. Sauce and an address are the hosts in either on the same subnetwork or connected LAN. A DDN standard specifies a host's IP. Since IP is defined by the DoD architecture model, it exists in an internetwork layer. Therefore, IP provides service for the protocol of the transport layer, and is based on service of a low rank network protocol. Various network access protocols exist in the low rank of IP, and an important radio-medium access protocol is especially contained in it, for example in an Ethernet protocol, an X.25 protocol, and this specification.
[0005]Internet Protocol was developed under assumption that the user who had the Internet address peculiar original respectively specified is connected to a network in the fixed position. However, it is usually rather that a user generally moves to here and there [network] about the computer of portable [which uses wireless protocols], or a handheld computer rather than an exception. A problem arises in that how to use this type is contrary to the implicit premise of a design of Internet Protocol as that result.
[0006]Unless a special premise is established about the position between computers now, there is no method of moving freely and enabling it to turn around the move computer which has a wireless data communication device, maintaining connection mutually. A certain move computer may often be able to exchange other two move computers and data for which data is directly unexchangeable in these very thing. As a result, when a user moves here and there in the interior of a room, the computer user in

particular in a conference room may be unable to predict which computer of the associate can be made reliance, in order to maintain network connection.
[0007]When the network layer address assigned to the host has no meaning about network topology, a problem arises about providing a move host with the optimal network layer routing. This problem arises because a host needs to provide sufficient information to have an identifier fixed even when a host moves and make network layer routing realizable in a network layer simultaneously.
[0008]
[Problem(s) to be Solved by the Invention]Therefore, the move computer group which can exchange data in accordance with the arbitrary interconnection courses as for which the purpose of this invention changes at the arbitrary times, It is providing the data communication system which can give the course (if it can do two or more hop) which can exchange data for all those computers.
[0009]The more concrete purpose of this invention is to provide the technique which can exchange data among two or more move computers in accordance with the course which always changes by using link layer routing without the help of a fixed station office.
[0010]
[Means for Solving the Problem]According to this invention, a method and a device for routing a packet between offices of a wireless data network are provided. A packet is transmitted between network offices using a routing table memorized in each network office. Each routing table memorized in each office provides a list of the office to each accessible offices, and a hop number required since each accessible office is arrived at. In order to maintain these tables in topology which changes dynamically, a link layer packet is transmitted from each office, and a table is updated. These link layer packets show a hop number required since an accessible office and this accessible office are arrived at from each office.
[0011]Routing information is announced publicly simultaneous transmissive communication or by multicasting periodically and in increment as change of topology detected in a link layer packet transmitted as a result of movement of an office within a network. In order to weaken change, information about frequency where a course changes is held. A decision which delays a public announcement of a course which changes soon based on this data, and weakens change of a routing table by it can be made. In order to prevent change between two link layer packets in which it interferes, a public announcement of a certain course is delayed.
[0012]
[Example]If a drawing, especially drawing 1 are referred to here, the architecture figure of Defense Data Network (DDN) which illustrates a network protocol layer is shown. The top layer 11 is a session layer containing the various application protocol 111 and the application programs 112 and 113. In addition to it, there is usually the E-mail (e-mail) application program 114. These communicate with the transport layer 4, i.e., a layer, with a protocol peculiar to application. For example, the application protocol 111 communicates with the layer 4 via the characteristic mode 115, The application protocol 112 communicates by the file transfer protocol (FTP) 116, an application program communicates with the Telnet protocol 117, and the e-mail application 114 communicates by Simple Mail Transfer Protocol (SMTP) 118.
[0013]The layer 4, i.e., the transport layer, may be constituted from the data link control protocol (TCP) transport layer 12, and the layer 3, i.e., a network layer, comprises the Internet Protocol (IP) layer 13. The two layers 12 and 13 contain the TCP/IP protocol of the lot which shares a common name and address space.
[0014]The link layer 14 2, i.e., a layer, comprises a link layer and a media-access-control (MAC) layer. Ethernet 141, DDN standard X.25 142, the wireless protocols 143, and various network access protocols containing the token ring 144 are contained in the link layer 14. Generally these are defined by the standard released by the standard organization. For example, Ethernet is defined by the IEEE (Institute of Electrical and Electronics Engineers) standard 802.3, and a token ring is defined by IEEE standard 802.5.
[0015]Finally, the layer 1 (not shown) is the physical layer. This layer is related to wiring, connection, and a transmission parameter including data coding. The layer of internetworking, and the detailed information on a protocol, E. Please refer to "Internetworking with TCP/IP written by Commer (Comer), Volume I:Principles, Protocols, and Architecture", and Prentice-Hall (1990).

[0016]Although the same technique as the layer 3 may be used in accordance with the conventional routing technique, operation of the desirable example of this invention targets especially the portion identified as the link layer or the layer 2 of the architecture shown in drawing 1. According to this invention, each mobile station needs to notify each of the present adjacent station publicly of the list of adjacent stations of itself. The entry in this list must announce publicly frequently enough that it changes dynamic considerably temporally, therefore all the move computers can always discover certainly other move computers of all the of that group. Each move computer agrees to relay data to another computer according to a demand. Thus, the move computer can exchange other move computers and data in a group, even when the target of data is not within the limits of direct communication. This method of sending data, using other computers as the halfway point is learned as routing.Routing was not applied to the above-mentioned problem about move computer systems by the link layer of the network protocol until now. Even if the notice in other move computers of which it is accessible from the specific computer in a group is performed by the link layer of a protocol according to this invention, therefore the protocol of the upper layer (for example, network layer) is in use, the method of this invention operates. The move computer group in a set constitutes a "network" new as a matter of fact, and does it so without management. The form of this communication is called "ad hoc (ad-hoc)" networking.
[0017]A move computer is used together with the "base station" which makes it possible to often exchange the computer and data of the others which maintain network connection along with the cable backbone in a building. In this case, since it may be assumed that a base station always has a lot of electric power and the electric power supply may be severely restricted to it as for the move computer, a base station mainly takes over a routing function. A base station participates in link layer routing in the form where he leaves that a move computer has access in all the move computers of a base station within the limits to each base station. When a move computer is within the limits of a base station, a base station is notified publicly of direct continuation nature by the periodic simultaneous transmissive communication of the adjacent station list. A base station may not carry out carrying out the simultaneous transmissive communication of the list which mobile station can cooperate, either, in order to create a data exchange course between the move computers of a different cell.
[0018]Since all the above-mentioned routing functions use link layer address specification technique (what is called "hardware address specification"), the above-mentioned method is almost applicable to the introductory equipment which uses a single physical media. The computer in a different network establishes and maintains the course for data exchange using network layer technique. The method of link layer routing written in this specification, Only in order to use it in the layer 3, it can also be made to suit by being able to use it together with such other techniques, or disregarding transmission of the protocol list of layers 3 in consideration of the address of the layer 3 instead of being an address of the layer 2 (namely, "hardware"). A single network-data course can be shown by a link layer, and two or more network-data courses can be processed by a network layer. The base station in a network facility has two or more responsibility of determining by which a required data path shall be established between a link layer and a network layer. When a base station is not included, a move computer uses chiefly link layer routing described on these specifications.
[0019]All the computers that carry out mutual operation in order to create a data path among these very thing are 1 time (.), for example to 1 time or several seconds in 1 second periodically. Or when the method of determining certainly is designed [that new simultaneous transmissive communication is required after all and], the simultaneous transmissive communication of the data requirement is carried out as it is needed. The data simultaneous transmissive communication by each move computer contains the routing table which has the following information at least about each address.
- The link layer address of an address.
- The number of hop (hop) required to reach an address.
- The time stamp of information in which the stamp was carried out by the address from the first and which was received about the address.
- ******** [wanting an address to work as a default router] (for example, an address is a base station). The transmitted routing table includes the hardware address of the move computer which transmits them by natural operation of link layer software. A routing table also contains again the time stamp created by the transmitting side. A specific move computer may also include the display which

shows which base station has given one's service to each move computer within the same cell with the routing algorithm which is going to determine whether to be accessible or not.
[0020]If a move computer receives such a routing table, the computer will begin to update the routing table of itself memorized locally. Each received path updates all the existing courses which show the same address and the following hop. A time stamp is replaced with a new time stamp, the increment of the hop number shown in each received path is carried out, and it is memorized. The hop number in alignment with the course to arbitrary computers is called "the distance (metric)" about the course. The address of the transmitting side of a routing table is memorized as an address of the following hop along the course to an address. (The last) Furthermore it met the course to an address, it is not necessary to memorize other addresses. A new entry is assigned to the address when the course entry corresponding to neither of the existing address (address, the following hop) pairs is received. Since it is related with the computer which emitted the routing table transmitted, the entry of a local routing table is created or updated, the distance about the entry is set to 1 and a computer is reached, needing only one hop is shown. In other words, these two computers (the transmitting side and the receiver of a routing table) are "adjacent stations."
[0021]Each address has a limited number (few) of alternate routes specified with a different link layer address, respectively about the following hop in alignment with the alternate-routing course. Although the course which has an always more new time stamp as a standard for making a transmission decision is chosen, it is not necessary to necessarily announce publicly (advertise). When an alternate route is otherwise possible, the course which has the shortest distance is memorized and other courses are forgotten. When it must choose between the alternate routes of the same distance, the course which has the newest time stamp is chosen. Since each move computer which transmits a local routing table carries out the stamp of each transmission with the local time value, almost all time stamps are emitted from a final destination. By the natural method spread by the routing table, a time stamp is chosen as each of other computer, and it can be determined that other computers of them maintain the routing entry about the move computer used as a starting point. When the move computer synchronizes, a time stamp is required only for one to the whole ad hoc community of a move computer.
[0022]Having stated above was only about the method of spreading and memorizing required routing data as a matter of fact. Details of the actual method of operating a routing table locally and updating it are given later. Data is used by two methods, the object for input packets, and the object for output packets. Operation of link layer routing will be best understood, if it thinks that it is carried out by the link layer and the thin protocol layer which is inserted between network layer protocols ("layer 3" in the stratification network term of International Organization for Standardization (ISO)) in a certain case. That is, link layer routing is performed after arbitrary high level protocol operations before other link layer operations about an output packet. About an input packet, link layer routing operation of this specification is performed before other high level protocol operations on the contrary after other link layer operations (for example, inspection of framing and data integrity).
[0023]About an output packet, link layer routing operation judges whether it is an adjoining computer, and a actual address when that is not right, The data which the link layer received is encapsulated and the new link layer header containing the packet type of a new destination address and the new layer 2 (link layer) is built. A new address is an address of the following hop along the course to a actual address. A packet type is a number on which it has agreed generally for starting the link layer routing procedure indicated here. That is, various processings of a new routing demand are started by the same method as an address decomposition protocol (ARP) requiring or high level protocol processing being started. Although the data which the link layer routing module received will be wrapped in a new packet type and a new address, that will not be right, but a packet is transmitted by the normal operation of a link layer.
[0024]If the packet which needs to be routed by such link layer operation at another address enters, the packet will be re-addressed by the following hop and will be sent to it. When the following hop is a actual address, a actual address and an actually required packet type are exposed by picking out the data of origin required for routing from a capsule, and discarding a capsule. When the following hop is not a actual address, except a packet type and a link layer header being changed into the address of the following hop with which the address on appearance met the course, it becomes remaining as it is

and a checksum or a data integrity sign is updated if needed. In the computer which performs link layer routing in any case, activation of the protocol above a link layer is not carried out.
[0025]Drawing 2 shows the ad hoc network 10 which has the both-directions radio link 50 and the move hosts MH1 thru/or MH8. MH1 which moves to the position of the next door of MH7 and MH8 from the position of the next door of MH2 as a dotted line shows is shown. By this invention, a packet can be routed without communication with the base station of the fixed wired network among the move hosts of the network 10. Information required in order to route a packet via the network 10 is included in the table (shown later) maintained by each move host. These tables are updated so that the topology from which the network 10 caused by a move host's movement changes continuously may be reflected.
[0026]This whole concept is updating that routing table, when each move host is made to do the simultaneous transmissive communication of that routing table periodically and such simultaneous transmissive communication is received from an adjacent station corresponding to it. Thus, when each simultaneous transmissive communication is processed, all the move hosts build a perfect description of the present topology of the interconnection between all the move hosts who desire to establish an ad hoc network and who cooperate. The entry of each routing table is tagged with a time stamp, and the time stamp is used in order to solve some problems which accompany address vector algorithms, such as the Bellman Ford routing. Such an algorithm is efficient calculatively. To a desired address, a course comes suddenly and the "best" distance is also chosen. "Distance" is the number of "hop" over which a packet must usually jump before reaching an address.
[0027]The course received in simultaneous transmissive communication is announced publicly by the receiver again, when carrying out the simultaneous transmissive communication of the routing information next, but. Since an input packet reaches an address and hop (namely, hop from the transmitting side to a receiver) is needed once again, a receiver adds increment to distance, before announcing a course publicly.
[0028]One of the most important parameters that should be chosen is the time of the interval which carries out the simultaneous transmissive communication of the routing information packet. However, if a move host receives the channel information corrected on new channel information or parenchyma, retransmission of the new information will be carried out immediately, and spread of the quickest routing information among all the move hosts who cooperate will be attained. This instant re-simultaneous transmissive communication introduces the new requirements that a protocol must converge as soon as possible. a move host's movement -- simultaneous transmissive communication -- oh, it will become a miserable thing, if ** happens and the usability of a radio medium falls.
[0029]A move host produces a destructive link, when moving to some places. A destructive link is expressed with an "infinite" (namely, bigger any value than maximum allowable distance) distance. When the link to the following hop is destroyed, an infinite distance is immediately assigned to all the courses which pass along the following hop, and the updated time stamp is assigned. Since it is considered that this is a substantial course change, in the routing information packet of simultaneous transmissive communication, such a correction course is indicated immediately. Construction of the information for describing a destructive link is in the only situation where a time stamp is created by arbitrary move hosts other than a destination moving host. When the move computer synchronizes, only one time stamp is required. The number of the time stamps created in order to be defined as the time stamp defined by the move host who is a source of release becoming even number and to show an infinite distance is odd. Thus, the time stamp of arbitrary "real numbers" replaces an infinite distance.
[0030]Probably in a very large move host group, adjustment is performed at the time in the intervals of the simultaneous transmissive communication of a routing information packet. Two types are defined in order to reduce the quantity of the information carried by these packets. One side is called a "total dump" and carries all the usable routing information. The type of another side is called an "increment type" and carries only the information which changed after the last total dump. The renewal of increment type routing is settled in one network protocol data unit (NPDU) by design. Also in the case of a comparatively small move host group, probably, two or more NPDU(s) are needed for a total dump. When a move host's movement does not take place, a total dump can be transmitted comparatively rarely. If movement becomes frequent and the size of increment approaches the size of NPDU,

scheduling of the total dump (the following increment decreases like) can be carried out.
[0031]If a move host receives new routing information (with the above-mentioned increment type packet usually), the information is beforehand compared with available information from a front routing information packet. The course which has a newer time stamp is used. The course which has an old time stamp is canceled. When the course which has the same time stamp as the existing course has a "better" distance, the course is chosen, and an existing path is canceled, or it memorizes as a thing not desirable [so]. The increment of the distance of the course chosen from the newly received simultaneous transmissive communication information is carried out only one hop, respectively. Scheduling of the newly recorded course or the course which shows the improved distance is carried out so that the present move host's adjacent station may be notified publicly immediately.
[0032]The timing skew between various move hosts is expected. Even when a certain amount of regularity is expected, it is considered somewhat that the period in the intervals of the simultaneous transmissive communication of the routing information by a move host is an asynchronous phenomenon. In the agent group transmitted independently such, in order to update a course, some change may occur by using the above-mentioned procedure. Even when a destination moving host does not move, the problem that a specific move host receives new routing information by the pattern which coheres and to which the course to another following hop is changed from a certain following hop may arise. This is because there are what has two courses, i.e., a late time stamp, and a thing which has a better distance about the new course which should be chosen. Although it is imagined that a move host receives two courses to the same address of having an always more new time stamp from the next (passing a different adjacent station) to the next, the course of a bad distance is always acquired at first. If not careful, this will cause the continuation burst of new course transmission for every time stamp new from the address. A new distance is spread to all the near move hosts, respectively, and the adjacent station spreads it to the adjacent station further, and it continues like the following.
[0033]The solution by the desirable example of this invention is that the public announcement of such a course is delayed, when a move host can judge, if the course which has a better distance is likely to appear soon. Although it must be usable in the course which has a late time stamp, unless it is a course to the address which was not able to reach before, it is not necessary to announce publicly immediately. therefore, it is for using the routing table held by each move host in those with two, and the method of one using it in forward packets, and another side is announced publicly via an increment type (and -- all) routing information packet. In order that arrival of the routing information which shows a better distance may judge near probability, a move host has to hold the history of the length which a specific course generally continues, before being updated by better distance.
[0034]Even if all the above-mentioned procedures are performed by which of the network layer (layer 3) of a protocol stack, and a link layer (layer 2), they are effective. Therefore, transmission can be carried out in the layer 2 with packet simultaneous transmissive communication to provide the ad hoc network of the move host who can communicate using some possible pro Kotor of the layer 3. In service of two corner points which did not carry out pro Kotor of the same layer 3 as a middle move host thereby, for example, a middle move host can transmit a packet now.
[0035]The address memorized by the routing table corresponds to the layer in which this ad hoc network protocol is carried out. That is, the operation in the layer 3 uses the network layer address and destination address for the following hop, and the operation in the layer 2 uses the media-access-control (MAC) address of the layer 2.
[0036]However, new requirements will be introduced if a MAC Address is used for a transfer table. Although layer 3 network protocol realizes communication based on three network addresses to have been troubled, the method of decomposing these layer three addresses into a MAC Address must be provided. Otherwise, the address decomposition mechanism from which a large number differ is established, and when using the decomposition mechanism, the loss of bandwidth corresponding in a radio medium will always be accepted. This is important and this is because such a mechanism will need the simultaneous transmissive communication and retransmission simultaneous transmissive communication by all the move hosts of an ad hoc network. All address solutions look like the bad condition in network standard operation. Therefore, if special attention is not paid, does every activity user understand it clearly?

[0037]The solution by this invention is including layer 3 protocol information about the operation in the layer 2 in addition to the routing information of the layer 2. Each move host who announces publicly whether each destination host supports the protocol of layer 3 throat, and announces the reachability to an address publicly will include the information about layer 3 protocol supported by an address other than the public announcement. What is necessary is to transmit this information, only when it changes, and it rarely happens. This information will be transmitted as a part of each "total-dump." Since each move host can support layer 3 protocol [some (or large number)], the length of this list must be variable.
[0038]The structure of the course entry in the internal transfer table maintained by each move host in the network 10 shown in drawing 2 is shown in Table 1.
[0039]
[Table 1]
destination address protocol dependence size -- hop [next] address Protocol dependence size distance Integer time stamp without numerals ; from an address -- integer installation time without numerals Device dependence (for example, 32 bits)
Pointer to stability data Pointer to device dependence protocol data Only device dependence and layer 2[0040]For example, the move host 4 in drawing 1 is examined. Each move host's address is expressed with MHX, and it is assumed that all the move hosts are supported by Internet Protocol (IP). It is assumed that all the time stamps are furthermore shown by TNNN_MHX. This MHX specifies the computer which created the time stamp, and TNNN is a value of time. Before the move host 1 moves from the move host 2, it is assumed that other move hosts of all the have an entry which has the time stamp TNNN MHX. At this time, the internal transfer table in MH4 is as follows (I would like to be minded by that a line corresponds to various move hosts and a sequence deals with the data described with said structure).
[0041]
[Table 2]
address The following hop Distance time stamp introduction . flag . Stable data protocol data MH1 MH2 2 T406_MH1 T001_MH4 PTR1_MH1 PTR2_MH1MH2 MH2 1 T128_MH2 T001_MH4 PTR1_MH2 PTR2_MH2MH3 MH2 2 T564_MH3 T001_MH4 PTR1_MH3 PTR2_MH3MH4 MH4 0 T710_MH4 T001_MH4 PTR1_MH4 PTR2_MH4MH5 MH6 2 T392_MH5 T002_MH4 PTR1_MH5. PTR2_MH5MH6 MH6 1 T076_MH6. T001_MH4 PTR1_MH6 PTR2_MH6MH7 MH6 2 T128_MH7 T002_MH4 PTR1_MH7 PTR2_MH7MH8 MH6 3 T050_MH8 T002_MH4 PTR1_MH8 PTR2_MH8[0042]From now on, since the installation time of almost all computers is almost the same, all the computers will be presumed for the almost same time to have come usable for MH4, for example. Since unit position has even time, all the time stamp fields are presumed that one link between computers was not destroyed, either. Since there is no course to the specific destination which is likely to replace or compete in other courses in drawing 1, all PTR1 MHX serves as a pointer to null structure. All protocol-data pointers point out the structure of having the following formats. protocol ID=IP, protocol address length =4 byte, and protocol address = [MHX.Net.addr.ess] -- here, MH1.Net.addr.ess, It is 4 bytes of IP address about MH1 displayed in a standard Internet4 octet form.
[0043]Table 3 shows the structure of the course entry in the route table announced publicly.
[0044]
[Table 3]
destination address Integer time stamp without protocol dependence size distance numerals ; from an address -- an integer without numerals -- size of the next layer three address 8 bits and 8 bits of protocol ID of the next address which is not already at the time of 0 -- address of the layer 3 following protocol[0045]The last item appears, only when the ad hoc algorithm operates in the layer 2. Since all the public announcements are suggested the following hop, it is not necessary to list. It is assumed that operation is performed in the layer 2, and a move host has address X:X:X:X:X:X, therefore a move host has MAC Address 1:1:1:1:1:1 (the standard format showed). Furthermore, it is assumed that IP is shown as what has protocol ID7 of the layer 3. Corresponding to it, it is assumed that the move host's MHX Internet address is expressed as X.X.X.X. Then, in the above-mentioned situation, the course announced publicly is expressed as follows.
[0046]

[Table 4]
Address Distance Time stamp Length ID. Layer three address length 1:1:1:1:1:1 2 T406_MH1 4 7 1.1.1.1 02:2:2:2:2:2 1 T128_MH2 4 7 2.2.2.2 03:3:3:3:3:3 2 T564_MH3 4 7 3. 3.3.3 04:4:4:4:4:4 0 T710_MH4 4 7 4.4.4.4 05:5:5:5:5:5 2 T392_MH5 4 7 5.5.5.5 06:6:6:6:6:6 1 T076_MH6 4 7 6.6.6.6 07:7:7:7. :7:7 2 T128_MH7 4 7 7.7.7.7 08:8:8:8:8:8 3 T050_MH8 4 7 8.8.8.8 0[0047]Here, the move host 1 moves around the move hosts 5 and 7, and it is assumed that it separated from other move hosts (especially move host 2). The new internal transfer table in the move host 4 is as follows.
[0048]
[Table 5]
address The following hop Distance time stamp introduction . flag . Stable data protocol data MH1 MH6 3 T516_MH1 T810_MH4 M PTR1_MH1 PTR2_MH1MH2 MH2 1 T238_MH2 T001_MH4 PTR1_MH2 PTR2_MH2MH3 MH2 2 T674_MH 3 T001_MH4 PTR1_MH3. PTR2_MH3MH4 MH4 0 T820_MH4. T001_MH4 PTR1_MH4 PTR2_MH4MH5 MH6 2 T502_MH5 T002_MH4 PTR1_MH5 PTR2_MH5MH6 MH6 1 T186_MH6 T001_MH4 PTR1_MH6. PTR2_MH6MH7 MH6 2 T238_MH7 T002_MH4 PTR1_MH7 PTR2_MH7MH8 MH6 3 T160_MH8 T002_MH4 PTR1_MH8 PTR2_MH8[0049]Although only the entry of MH1 shows a new distance, many new time stamp entries are received at the time of a between. That is, the first entry must be announced publicly in renewal of the increment routing information which will happen continuously by the time it has the flag M (M of the distance Metric) and the following total dump arises. When the move host 1 moved around the move hosts 5 and 7, the renewal of instancy of increment type routing information was started. The simultaneous transmissive communication of this was carried out to the move host 6 after that. The move host 6 judged that important and new routing information was received, and updating was started the instancy which carries the new routing information about the move host 1 to the move host 4. When the move host 4 receives this information, he will do the simultaneous transmissive communication of it at all the intervals to the total dump of the following routing information. In the move host 4, the renewal of increment type public announcement routing has the following forms.
[0050]
[Table 6]
address . distance . Time stamp 4 4 4 4 4 4 0 T820_MH41 1 1 1 1 1 3 T516_MH12 2 2 2 2 2 1 T238_MH23 3 3 3 3 3 2 T674_MH35 5 5 5 5 2 T502_MH56 6 6 6 6 6 1 T186_MH67 7 7 7 7 7 2 T238_MH78 8 88 8 8 3 T160_MH8 [0051]In this public announcement, since the move host 4 is announcing publicly, the information about the move host 4 becomes the beginning. Since it is only one thing that has an important path change which has influence since the move host 1 has a low address not but, the information about the move host 1 becomes the next. The whole renewal of increment type routing has the following forms.
[0052]
[Table 7]
Transmitted data Course in which the course time stamp in which the route distance by which the protocol availability information on a "local station address" and distance ** 0 horizon 3 was changed was changed was changed [0053]There is no move host who changed layer 3 protocol structure in this example. Since there was a computer in a new position, the routing information was changed. All the computers transmitted a new time stamp to the newest. When there are too many updated time stamps and they are not settled in a single packet, only the settled time stamp is transmitted. These are chosen in order to transmit impartially covering some increment renewal intervals.
[0054]Such a format is not required for transmission of all the routing information packets. A required number of packets are used and all usable (including required layer three address information) information is transmitted.
[0055]In order to process operation of some of time dependency within an ad hoc network protocol, a standard event list structure must be maintained. The example of a node may be as follows.
[0056]
[Table 8]
Event time phenomenon discernment phenomenon data (pointer to a course entry)
[0057]An event list is inspected when the clock of a computer carries out a clocking. When the first node expires, a phenomenon node is pulled out from a list, the discernment used in order to call

correction procedure, and the phenomenon data handed over as an argument to a phenomenon manipulation routine.

[0058]The following explanation explains the directions at the time of preventing change of a routing table entry about the waiting waiting time table for stability. Since the renewal of a course is chosen in accordance with the following standards, a general problem produces it.

- When a time stamp is newer, the course is always preferred.
- Otherwise, although a time stamp is the same, the course is preferred when distance is better (short).

In order to understand a problem, it is assumed that the move host received in the order which made a mistake in two courses of having a discernment time stamp. That is, it is assumed that the move host 4 receives the following hop of a long distance by the beginning, and gets another following hop of distance with a time stamp short similarly just after that. This is not so regular, and when there are many move hosts who transmit updating, it may happen. Instead, when the move host is completely operating independently with a remarkably different transmission interval, corresponding to it, this situation may happen by fewer hosts. Anyway, in drawing 3, although both are connected to common address MH9, other move hosts assume that there is sufficient move host to cause this problem into two separate move host groups which are not common. It is assumed that all the move hosts are transmitting updating every about 15 seconds, move host MH2 has a course of 12 hop to MH9, and move host MH6 has a course of 11 hop to MH9. It is assumed that the renewal of the routing information from MH2 reaches MH4 about 10 seconds ago rather than renewal of the routing information from MH6. This is performed whenever a new time stamp is published from move host MH9. So that it may happen, when not settled in renewal of the increment packet with all the single hosts which has too many hosts who have the new renewal of a time stamp actual, for example, A time lag can become severe when the arbitrary move hosts of the group II begin to publish the renewal of a time stamp with two or more increment type renewal intervals. Generally, it is expected that the difference of the updating delivery in drawing 3 becomes severe, so that a hop number becomes large.

[0059]Stable waiting time data is memorized on the table which is specified by the first two fields and which has the following forms.

[0060]

[Table 9]

The destination address following hop address last stable waiting time average stable waiting time

[0061]It is assumed that renewal of new routing information reaches the move host 4. The time stamp of a new entry is the same as the time stamp in the entry used now, and a newer entry has a worse (that is, longer) distance. Then, if the move host 4 does not use a new entry when he makes the next transmission decision, he learns, and he is **. However, the move host 4 can investigate the stable waiting time table of the course, in order to decide for which it waits before not announcing a new course publicly immediately and announcing it publicly. Average stable waiting time is used for this determination. For example, before announcing a course publicly, the move host 4 can determine to be delayed (average stable waiting time *2).

[0062]This is a dramatically useful thing. It is because this bad result will probably be repeated whenever that result will spread via a network and renewal of the time stamp of move host MH9 will spread via an ad hoc network, if a course with an unstable possibility is announced publicly immediately. On the other hand, when the link which goes via move host MH6 breaks truly, the course which goes via MH2 should be announced publicly immediately. In order to attain this, when move host MH4 has a history of change, link destruction should be enough detected early so that the middle host in the group II may discover a problem and the renewal of increment which shows an infinite distance about the course along the course to move host MH9 and by which the trigger was carried out may be started. That is, it seems that the problem has other effects which govern enough time path update patterns to make powerless the mechanism in which change is avoided when a problem similar to change of renewal of routing which took place before appears. The course which has an infinite distance must be immediately announced publicly by definition.

[0063]In order to bias a damping mechanism in favor of the newest phenomenon, the newest measured value of the stable waiting time of a specific route must be counted by a bigger load factor than old measured value. And before it is considered by the important thing truly that a course is a stable state,

the parameter with which which shows whether it must be a stable state must be chosen as it. This will specify the maximum of stable waiting time of one pair of addresses (an address, the following hop) in a stable waiting time table after all. A course more stable than the course which has this maximum causes updating by which the trigger was carried out to the case where it is replaced in another course which has the following hop or distance from which it differs.

[0064]Although the way link layer software carries out routing table management is common knowledge, some details are shown about an embodiment specific for explanation. This table itself is an array of the fixed size entry often statically assigned by the data memorized in the data memory of an operating system so that that might be right. Each entry has an integer field which specifies the "next" entry, and, thereby, becomes like access of the list which access to the routing table of the normal mode twisted and (it is an everyday occurrence when it is the array the size was statically decided to be) linked to linear search. Each destination node can have at most three alternate route. These courses carry out an optimal path first, and are memorized as three continuous elements of a list. When the shown optimal path goes wrong or it is judged that the data is out of condition, the following course "being promoted (promoted)" actually.

[0065]When the new renewal of routing is thought that updating is applied to a table from an "adjacent station" between said, processing for deleting an entry out of condition is also performed. An entry out of condition is defined as the entry to which updating was not applied within the update period of latest 23. Since it is expected that each adjacent station sends updating periodically, if updating is not received for a while, a receiver may judge that a corresponding computer is not an adjacent station any longer. If it happens, every course which uses the computer as following hop will be deleted including the course which shows the computer as a actual address (once contiguity). When there are many update periods generated before an entry is determined, the number of routing entries out of condition will increase, but a transmission error also increases. Although a transmission error is being often in the case of many radio embodiments, a possibility of generating also when using a CSMA type simultaneous transmissive communication medium is high. When a link breaks, scheduling of the course of an infinite distance should be carried out to the course depending on the link and its link.

[0066]A time-out procedure when judged with data of drawing 4 being out of condition is shown. First, with the functional block 40, a course entry is obtained from event list data, and, subsequently a course is deleted from an internal table with the functional block 41. An infinite distance is inserted in the table of the course announced publicly with the functional block 42, and then the examination for which the address judges whether it is the following hop of other addresses by the judgment blocks 43 is done. When that is right, it is the functional block 44 and the course of an infinite distance is announced publicly to the address which cannot be reached now. As shown in drawing 5, "ADVERTISE" phenomenon processing includes the processing which inserts the course specified as the route list announced publicly with the functional block 45, and the processing which subsequently sets an INCREMENTAL flag with the functional block 46. Simultaneously, a SHOWN YET flag is reset. The course inserted will show a distance infinite to an address.

[0067]Drawing 6 shows the logic of renewal transmission of an increment type from a move host. This processing begins from the functional block 47, and change of protocol availability is inserted. Subsequently, a public announcement route list is scanned with the functional block 48, FLAGS and SHOWN YET are 0 in the judgment blocks 49, or an inspection is conducted. If this condition is suited, with the functional block 50, that course will be inserted and a flag will be set. Next, an examination is done by the judgment blocks 51 and it is judged whether an output packet is too full. When too full, before processing finishes, scheduling of the total dump is carried out with the functional block 52, when that is not right, it returns to the functional block 48 and a public announcement route list is scanned.

[0068]Even if a public announcement route list is scanned, an examination is done by the judgment blocks 53 and it is judged whether FLAGS and INCREMENTAL are 0. When it is 0, processing returns to the functional block 48, and when that is not right, the course is inserted with the functional block 54. An examination is done by the judgment blocks 55 and it is judged whether output PAKKETO is too full. Scheduling of the total dump is carried out with the functional block 52, when too full, when that is not right, a public announcement route list is again scanned with the functional block 56, but it begins from LAST ADVTIMESTAMP at this time. When a public announcement route list is scanned, an

examination is done by the judgment blocks 57 and it is judged whether FLAGS and NEW TIMESTAMP are 0. When it is not 0, a course is inserted with the functional block 58, an examination is done by the judgment blocks 59, and it is judged whether an output packet is too full. When too full, it is set to the last course in which LAST ADV TIMESTAMP was shown by the functional block 60, and when that is not right, LAST ADV TIMESTAMP is set to zero with the functional block 61, and processing is completed.

[0069]Drawing 7 shows the logic of total-dump transmission from a move host. First, an examination is done by the judgment blocks 62, and it is judged whether any course is shown. When not shown, before processing finishes, it is the functional block 63, and increment transmission is performed and scheduling of the total dump is carried out again. When that is not right, it is the functional block 64 and all usable protocols are inserted according to the specified table format. Next, the "FLAGS" field where all public announcement courses are inserted with the functional block 65 according to the form of a table is deleted. Finally, with the functional block 66, increment is reset in all the public announcement courses, and processing is completed.

[0070]Drawing 8 shows the logic of the total-dump processing at the time of reception. Input data is first scanned with the functional block 67, and a course is new in whether a time stamp is new at the judgment blocks 68 at the judgment blocks 69, or it is judged whether it has a new distance and whether one of protocols were changed by the judgment blocks 70 again. When a time stamp is new, it is the functional block 71, and the present value is put on the inner path appointed table, scheduling of the timeout phenomenon is carried out again, and new timeout is marked in a table. Next, with the functional block 72, measurement of the stable waiting time of the course is started, and processing is completed. On the other hand, a course is new, or when it has a new distance, it is the functional block 73 and scheduling of the error activity is carried out. Subsequently, with the functional block 74, stable waiting time is updated and processing is completed. On the other hand, when one of protocols change, layer 3 suitable activity is changed for example, using ARP table management with the functional block 75.

[0071]Drawing 9 shows the increment type update process at the time of reception. . [whether input data was scanned with the functional block 76, and protocol availability was changed by the judgment blocks 77, and] It is judged whether a time stamp is the same at the judgment blocks 80 in whether a time stamp is old in whether a course is new at the judgment blocks 78 at the judgment blocks 79, and distance is shorter. When protocol availability is changing, suitable layer 3 manipulation routine is called with the functional block 81, and it progresses to the judgment blocks 78. When a course is new, scheduling of the renewal of output increment is carried out with the functional block 82, and processing is completed. When a time stamp is old, an examination is further done by the judgment blocks 83, and a course judges whether it has an infinite distance. When a course does not have an infinite distance, it is canceled with the functional block 84 and processing is completed. When a course has an infinite distance, a SHOWN YET flag is reset with the functional block 85, and processing is completed. When a time stamp is the same and distance is shorter, the present stable waiting time is updated with the functional block 86, and it is first put into an entry new on a public announcement list with the functional block 87. Next, with the functional block 88, a SHOWN YET flag is reset, increment is set, a related "ADVERTISE" phenomenon is deleted, and processing is completed. It returns to the judgment blocks 80, when a result is denial, it progresses to the functional block 89, and the course entry in an internal table is used, and timeout is reset. Next, with the functional block 90, scheduling of the recovery is carried out after the present evaluation of stable waiting time, and processing is completed.

[0072]After stable waiting time passes over drawing 10, it shows the flow chart for inserting a course in a public announcement course. This processing will start, if the recovery timer set with the functional block 90 of drawing 9 sounds with the functional block 101. If this happens, it will be judged whether it is the same as the course on which the examination was done by the judgment blocks 102 and which was notified publicly of the established course. When the same, it is not necessary to perform anything and processing is ended. However, when it differs, before SHOWN YET is reset with the functional block 103 and processing finishes, scheduling of the following renewal of increment is carried out with the functional block 104.

[0073]There is a data field of the addition transmitted as a part of each entry in the routing table by

which simultaneous transmissive communication is carried out by each computer (a mobile station or a base station) which involves besides the above. These fields are decided with other protocols for which it depends on operation of a high level protocol or a link layer, for example. For example, in order to enable right ARP operation, each routing table entry may also have to include the Internet Protocol (IP) address corresponding to a destination address. When using a routing function for an adjacent station, this is performed in order to make a middle computer usable, and publishes "Proxy ARP" instead of routing of ARP simultaneous transmissive communication.
[0074]The false C code which is used in order to attain an ad hoc network among the move hosts who cooperate and which describes various procedures is listed below.
[0075]
```
struct forwarding route entry{
 address t destination;

 address t next hop;
 value t metric;
 value t settling time;
 value t install time;
 protocol list;
 flags;
}
/*
```

This table is initialized so that the data about the move host who performs these procedures may always be included.
* /struct advertised. route. entry{address t destination; value t metric; proto ptr protocol list;struct advertised route entry *advertised route table {= myaddress, 0,my protocol list};struct protocol list {value t protocol type; value t address size; u char[] layer3 address ;}/** each move host has to maintain two tables of a course entry.
* – Course *//** each move host used for the course entry *–transmission announced publicly has to maintain the phenomenon Li * strike which has a node about various kinds of possible timeout phenomena. The possible phenomenon is as follows.
* * which times out – routing table entry – In order to avoid change which may take place, course * to the public announcement table by which the public announcement was delayed is added.
* carry out the simultaneous transmissive communication of the – public announcement periodically (an increment type –– or –– all).
*/Timeout(){get event from list(); switch (event type) case ROUTE TIMEOUT: bad route=event type–>routeif; (.) bad route–>metric=1 / * ****, */ for (route.) from which the adjacent station died =. first; . For all the courses in a /* table. It attaches and is */){if route–>next hop = bad route){rOute–>metric = INFINITE METRIC; route–>flags = METRIC CHANGED;route–>timestamp. | =1;} bad route–>flags.} I=METRIC CHANGED bad. route–>metric=INFINITE. METRIC;. bad route–>timestampl=1; . /*. */ do incremntal(); break; case ADD ADVERTISEMENT: route–>flags I=CHANGED; break; case DO ADVERTISEMENT:if (.) which carried out the increment only of 1 full dump scheduleddo full dump();else do incremental(); break;}}struct settling time table{address t de stination; time t settling. time;. value t number of next hops; addr list next hop list;}struct next hop list{address t next hop; list ptr *next hop list;}. do full dump(){get empty. NPDU()for; (.) A /* public announcement Each course */) {copy route into NPDU() if (NPDU full) (transmit NPDU(); get empty NPDU();} route–>flags &= /* change in the routing table carried out. A bit. */NOT (CHANGED.) to reset I CHANGED PROTOCOL I CHANGED METRIC;} A */ schedule full dump(USUAL PERIOD);}/** incremental dump to be taken notice of by that local station data was automatically contained by the /* above, Some following portions are piled up.
* The entry about – transmitting station (namely, this move host).
* – Entry about move host * which corrected a new move host or layer 3 protocol availability information.

* The entry about the new move host by whom -- routing information was changed on parenchyma.
* -- Entry only reflecting a new time stamp.
* An increment packet is restrained so that it may fit only in one layer 3 packet (network protocol data YU * knitting). The place * ** too much important change is to report must carry out scheduling of the total dump. renewal of a time stamp -- * -- pursuing the renewal of a time stamp reported at the end, when too large to report -- * next time -- and it starts.
* /do incremental dump(){get empty NPDU(); the new time stamp of a local station is transmitted to the /* beginning. Distance 0*/ if (.) route to myself->timestamp. & 0x00000001! =0 printf. ("unexpected internal time stamp error**r**n"); route to myself->timestamp = route to myself +2;copy route into NPDU(route to myself) for () route=first;. Each course */) if (route->flags & PROTOCOL CHANGED) copy route into NPDU(route) if (NPDU full) (schedule full dump(in a /* public announcement routing table IMMEDIATE;. each course */in a printf (Unexpectedly full incremental!¥n"); transmit NPDU(); get empty NPDU();}} for (route=first;/* public announcement routing table {. if (route->flags & ALREADY DONE) continue; /*. This above already. Shown */ if (route->flags & METRIC CHANGED) copy route into NPDU(route) if (NPDU full) (schedule full dump(IMMEDIATE);. printf("not expecting all the increment incremental!**n"); for (route=last timestamp shown;.) transmit NPDU(); get empty NPDU();}} /* */{if (route->flags.) & ALREADY DONE continue; . This by the /* above already. Shown */ if (route->flags & TIMESTAMP CHANGED) {copy route into NPDU(route) last timestamp shown = route;} if (NPDU full) (.) break; */} which stops construction of a /* increment packet If a transmit NPDU();}/** move host receives routing information from one of adjacent stations,} It is [whether each * course entry of a packet is investigated and the inner path appointed table is updated, and] ****** * **. when an input packet is a total dump, different information on parenchyma is usually expected -- * -- there is nothing. the case where it has a but more short distance in which newness is equivalent when newer -- * -- a new course is accepted.
* When * input route is accepted based on the standard of a newer time stamp, determine [whether * and a new course are announced publicly and]. It depends for this determination on history * of the past of the course acquired from the transmitting side (namely, the following hop) of the packet about specific address move Hoss * TO.
* * to be taken notice of by that only 1 must carry out the increment of the distance the course which passes along * next hop was indicated to be about the input * courses in which only one hop is more arbitrary than the course to the following hop since it reflects becoming long (since it is the hop from this move host to following hop *).
Each entry in a */process incoming route update(){must schedule incremental = FALSE; for (new route=packet data; /* packet. */{old route = find(new route,route table); new route->metric =new route->metric +1; if (new route-> to perform timestamp > old route->timestamp) {new route->timeout = calculate timeout(new route); replace (old routej new route);. route table); delete timeout event (old route); schedule timeout event (new route); if (new route-> type & CHANGED PROTOCOL){must schedule incremental = TRUE; new route->flags I=CHANGED PROTOCOL; new route-> install time = current time();} else if ((new route->type & CHANGED METRIC) II (new route->metric <old route->metric { must schedule incremental = TRUE; new route->flags I=CHANGED METRIC; new route-> install time =current time();} else if (new route->metric >= old route->metric) {stable time = check settling time (.)newroute if (0 ==stable.) time /* -- it. */ new route->flagsI= CHANGED; else enter event list(new route, stable time,ADD ADVERTISEMENT);}} else if ((new routeto announce publicly ->timestamp == old route->timestamp&& (new route->metric < old route->) metric)) {enter settling time data (old route, new route); new route->timeout = calculate timeout(new route);. replace (oldroute, new route, route table); delete timeout event (old route); schedule timeout event (new route);. new route->flags I=CHANGED METRIC; new route->install time = current time();}} if (must schedule incremental) {schedule incremental(IMMEDIATE); . if (incoming packet->packet type ==FULL DUMP) In order to weaken printf;("Full dump has new, unreported data!¥r¥n")}}/** change, The data about the frequency of course change is held. Although a course public announcement is received in a certain situation by the specific move host who has * and the same time stamp, it is possible that receive by an "order * foreword blank", namely, two courses of having the same time stamp short * Are more, and distance is reached first.
* Last stability waiting time * average stability waiting time *2 ** data is held.

* Average stable waiting time ** * Obtains those results, and a pre- average is increased 16 times, and the present value is doubled, and it is calculated by dividing it by 18. This is effective in few * Using the newest result and giving big dignity to it rather than 16 front results.
* /enter settling time. (new route, old route) {route. data = find (.) new. route->destination, old route->next hop, settling time table); settling time = (16* route data->settling time) + 2* (current time. () - old route->install time); settling time = settling time ¥ 18;}check settling time (new route){route data = find (new route, settling time table); settling time data =route data->settling time; if (settling time data == NULL)return 0if; (.) settling time data > MAXIMUM DELAYreturn 0;else ret. urn (settling time data);
[0076]Although this invention was explained based on one desirable example, it will be understood by the person skilled in the art that this invention can be corrected and carried out by the meaning of an attached claim and within the limits. The new routing algorithm of this invention is developed in order to enable creation of the "ad hoc network" especially needed for operation of a move computer most dramatically. However, operation of this routing algorithm itself and an "ad hoc network" can be advantageously used also in the situation where a move computer is not included. For example, this routing algorithm is applicable to the situation of needing few (comparing with a link condition routing algorithm) memory requirements. Operation of an "ad hoc network" is applicable not only to a radio move computer but a cable move computer. Therefore, generally, this invention provides the new order routing algorithm of an address, and it is compensated with this algorithm by the technique which weakens change.
[0077]As a conclusion, the following matters are indicated about the composition of this invention.
[0078](1) Between two move hosts combined with the ad hoc network which comprises two or more move hosts who do not have a fixed position although it has a peculiar network address, respectively, In [are the method of routing the information on a packet, and] each move host, The stage of memorizing a routing table including the "distance" defined as a hop number from a sauce move host to a destination moving host, With the stage which announces a course publicly when the move host does periodically the simultaneous transmissive communication of the routing table memorized by each move host, and the time stamp emitted from the destination moving host. The stage which tags the entry of each routing table, and the stage which updates the routing table memorized by the move host for every destination moving host based on the simultaneous transmissive communication received from other move hosts, A method including the stage which chooses the course for transmitting the information on a packet from a sauce move host as the stage which carries out retransmission of the new routing information which each move host received from the contiguity move host, and a course which has the best "distance" about a desired destination moving host.
(2) The routing method given in the above (1) characterized by performing routing by the link layer of an ad hoc network according to the network standard in which an ad hoc network contains a network layer and a link layer.
(3) A shorter distance or an infinite distance is defined as the course which it has by the new course, and it an infinite distance, Express the destroyed link, namely, it becomes impossible for a specific address to reach, Therefore, it means that attainment of all the addresses of the others depending on the address in which this new attainment is impossible becomes impossible in itself, The routing method given in the above (1), wherein the immediate execute of said stage which carries out retransmission of the new routing information received from the contiguity move host is done by the move host at the time of reception of new routing information.
(4) By determining the average stable waiting time of the stage of holding the data about the frequency where the course memorized by said routing table changes, and the course memorized by said routing table, The stage which measures the stability of a course, and the stage of memorizing the stable waiting time of the measured course on a stable waiting time table, The routing method given in the above (1) which accesses on a stable waiting time table before a public announcement stage, delays the public announcement of the course which may change soon, and includes further the stage which weakens change of the information in said routing table by that cause.
(5) The routing method given in the above (4) which includes further the stage of performing weighting in the course stable waiting time measured by counting the newest measured value of the stable waiting time of the specific course which has a bigger load factor than old measured value.
(6) The stage where an ad hoc network memorizes routing information to said routing table further

based on a move host's network layer address, By determining the average stable waiting time of the stage of holding the data about the frequency where the course memorized by said routing table changes, and the course memorized by said routing table, The stage which measures the stability of a course, and the stage of memorizing the stable waiting time of the measured course on a stable waiting time table, The routing method given in the above (1) which accesses on a stable waiting time table before a public announcement stage, delays the public announcement of the course which may change soon, and includes further the stage which weakens change of the information in said routing table by that cause.
(7) The stage of memorizing routing information to said routing table based on a move host's link layer address, By determining the average stable waiting time of the stage of holding the data about the frequency where the course memorized by said routing table changes, and the course memorized by said routing table, The stage which measures the stability of a course, and the stage of memorizing the stable waiting time of the measured course on a stable waiting time table, The routing method given in the above (1) which accesses on a stable waiting time table before a public announcement stage, delays the public announcement of the course which may change soon, and includes further the stage which weakens change of the information in said routing table by that cause.
(8) The routing method given in the above (1) which includes further the stage which pursues network layer protocol availability data for every address.
(9) It comprises two or more move hosts who do not have a fixed position although it has a peculiar network address, respectively, Including a network layer and a link layer between two move hosts combined with the ad hoc network according to a network standard, In [are the method of routing the information on a packet, and] each move host, The stage of memorizing a routing table including the "distance" defined as a hop number from a sauce move host to a destination moving host, With the stage which announces a course publicly when the move host does periodically the simultaneous transmissive communication of the routing table memorized by each move host, and the time stamp emitted from the destination moving host. Based on the stage which tags the entry of each routing table, and the simultaneous transmissive communication received from other move hosts, It is a stage which updates the routing table memorized by the move host for every move host, Said updating is limited to the new course defined as the course which has a better distance or an infinite distance, The updating stage meaning attainment of all the addresses of the others which an infinite distance expresses a destructive link, namely, it becomes impossible for a specific address to reach therefore, and are dependent on the address in which this new attainment is impossible becoming impossible in itself, The retransmission stage which is a stage where each move host does retransmission of the new routing information received from the contiguity move host, and will be immediately performed if a move host receives new routing information, A method including the stage which chooses from a sauce move host the course which transmits the information on a packet as a course which has the shortest "distance" about a desired destination moving host.
(10) By determining the average stable waiting time of the stage of holding the data about the frequency where the course memorized by said routing table changes, and the course memorized by said routing table, The stage which measures the stability of a course, and the stage of memorizing the stable waiting time of the measured course on a stable waiting time table, The routing method given in the above (9) which accesses on a stable waiting time table before a public announcement stage, delays the public announcement of the course which may change soon, and includes the stage which weakens change of the information in said routing table by that cause.
(11) The routing method given in the above (10) which includes further the stage of performing weighting in the course stable waiting time measured by counting the newest measured value of the stable waiting time of the specific route which has a bigger load factor than an old phenomenon.
[Effect of the Invention]The move computer group which can exchange data in accordance with the changing arbitrary interconnection courses at the arbitrary times can provide the data communication system which can give the course which can change data into the computer.

[Translation done.]

* NOTICES *

TECHNICAL FIELD

[Industrial Application]Generally this invention relates to details more about a wireless data communication system at link layer routing for move computers.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

PRIOR ART

[Description of the Prior Art]The network protocol of various many is defined. For example, the International Business Machines (IBM) condominium ration established the System Network Architecture (SNA) which defines the specific protocol which enables the IBM computer and communication for the compatible computers. International Organization for Standardization (ISO) is the international organization which announced the standard for the open systems interconnection (OSI) architecture. The Defense Data Network (DDN) standard has established the standard for Internet Protocol (IP) which supports the interconnection of a local area network (LAN). IP defined the service provided for a user and specifies the mechanism required in order to support those services. This standard defined service required for an underlying protocol layer again, described the interface of a higher rank and a low rank, and has described the outline of execution environment service required for operation.
[0003]A data link control protocol (TCP) is an offer transport protocol about the data communications between terminals with the high reliability of a connection basis in packet-switching computer LAN and an internetwork. IP and TCP are indispensable in order to use all the packet switching networks of the U.S. Department of Defense (DoD) which has a possibility of crossing the boundary of a network or a subnetwork, and connecting, or using connectivity. In such a network used for internetworking, network elements, such as a host, a front end, and a gateway, must carry out TCP/IP.
[0004]IP is designed carry out interconnection of the packet switched communication LAN, and constitute an internetwork. IP transmits the block of the data called the Internet diagram from sauce to an address via the Internet. Sauce and an address are the hosts in either on the same subnetwork or connected LAN. A DDN standard specifies a host's IP. Since IP is defined by the DoD architecture model, it exists in an internetwork layer. Therefore, IP provides service for the protocol of the transport layer, and is based on service of a low rank network protocol. Various network access protocols exist in the low rank of IP, and an important radio-medium access protocol is especially contained in it, for example in an Ethernet protocol, an X.25 protocol, and this specification.
[0005]Internet Protocol was developed under assumption that the user who had the Internet address peculiar original respectively specified is connected to a network in the fixed position. However, it is usually rather that a user generally moves to here and there [network] about the computer of portable [which uses wireless protocols], or a handheld computer rather than an exception. A problem arises in that how to use this type is contrary to the implicit premise of a design of Internet Protocol as that result.
[0006]Unless a special premise is established about the position between computers now, there is no method of moving freely and enabling it to turn around the move computer which has a wireless data communication device, maintaining connection mutually. A certain move computer may often be able to exchange other two move computers and data for which data is directly unexchangeable in these very thing. As a result, when a user moves here and there in the interior of a room, the computer user in particular in a conference room may be unable to predict which computer of the associate can be made reliance, in order to maintain network connection.
[0007]When the network layer address assigned to the host has no meaning about network topology, a problem arises about providing a move host with the optimal network layer routing. This problem arises because a host needs to provide sufficient information to have an identifier fixed even when a host

moves and make network layer routing realizable in a network layer simultaneously.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention]The move computer group which can exchange data in accordance with the changing arbitrary interconnection courses at the arbitrary times can provide the data communication system which can give the course which can change data into the computer.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]Therefore, the move computer group which can exchange data in accordance with the arbitrary interconnection courses as for which the purpose of this invention changes at the arbitrary times, It is providing the data communication system which can give the course (if it can do two or more hop) which can exchange data for all those computers.
[0009]The more concrete purpose of this invention is to provide the technique which can exchange data among two or more move computers in accordance with the course which always changes by using link layer routing without the help of a fixed station office.

[Translation done.]

MEANS

[Means for Solving the Problem]According to this invention, a method and a device for routing a packet between offices of a wireless data network are provided. A packet is transmitted between network offices using a routing table memorized in each network office. Each routing table memorized in each office provides a list of the office to each accessible offices, and a hop number required since each accessible office is arrived at. In order to maintain these tables in topology which changes dynamically, a link layer packet is transmitted from each office, and a table is updated. These link layer packets show a hop number required since an accessible office and this accessible office are arrived at from each office.
[0011]Routing information is announced publicly simultaneous transmissive communication or by multicasting periodically and in increment as change of topology detected in a link layer packet transmitted as a result of movement of an office within a network. In order to weaken change, information about frequency where a course changes is held. A decision which delays a public announcement of a course which changes soon based on this data, and weakens change of a routing table by it can be made. In order to prevent change between two link layer packets in which it interferes, a public announcement of a certain course is delayed.

[Translation done.]

EXAMPLE

[Example]If a drawing, especially drawing 1 are referred to here, the architecture figure of Defense Data Network (DDN) which illustrates a network protocol layer is shown. The top layer 11 is a session layer containing the various application protocol 111 and the application programs 112 and 113. In addition to it, there is usually the E-mail (e-mail) application program 114. These communicate with the transport layer 4, i.e., a layer, with a protocol peculiar to application. For example, the application protocol 111 communicates with the layer 4 via the characteristic mode 115, The application protocol 112 communicates by the file transfer protocol (FTP) 116, an application program communicates with the Telnet protocol 117, and the e-mail application 114 communicates by Simple Mail Transfer Protocol (SMTP) 118.
[0013]The layer 4, i.e., the transport layer, may be constituted from the data link control protocol (TCP) transport layer 12, and the layer 3, i.e., a network layer, comprises the Internet Protocol (IP) layer 13. The two layers 12 and 13 contain the TCP/IP protocol of the lot which shares a common name and address space.
[0014]The link layer 14 2, i.e., a layer, comprises a link layer and a media-access-control (MAC) layer. Ethernet 141, DDN standard X.25 142, the wireless protocols 143, and various network access protocols containing the token ring 144 are contained in the link layer 14. Generally these are defined by the standard released by the standard organization. For example, Ethernet is defined by the IEEE (Institute of Electrical and Electronics Engineers) standard 802.3, and a token ring is defined by IEEE standard 802.5.
[0015]Finally, the layer 1 (not shown) is the physical layer. This layer is related to wiring, connection, and a transmission parameter including data coding. The layer of internetworking, and the detailed information on a protocol, E. Please refer to "Internetworking with TCP/IP written by Commer (Comer), Volume I:Principles, Protocols, and Architecture", and Prentice-Hall (1990).
[0016]Although the same technique as the layer 3 may be used in accordance with the conventional routing technique, operation of the desirable example of this invention targets especially the portion identified as the link layer or the layer 2 of the architecture shown in drawing 1. According to this invention, each mobile station needs to notify each of the present adjacent station publicly of the list of adjacent stations of itself. The entry in this list must announce publicly frequently enough that it changes dynamic considerably temporally, therefore all the move computers can always discover certainly other move computers of all the of that group. Each move computer agrees to relay data to another computer according to a demand. Thus, the move computer can exchange other move computers and data in a group, even when the target of data is not within the limits of direct communication. This method of sending data, using other computers as the halfway point is learned as routing.Routing was not applied to the above-mentioned problem about move computer systems by the link layer of the network protocol until now. Even if the notice in other move computers of which it is accessible from the specific computer in a group is performed by the link layer of a protocol according to this invention, therefore the protocol of the upper layer (for example, network layer) is in use, the method of this invention operates. The move computer group in a set constitutes a "network" new as a matter of fact, and does it so without management. The form of this communication is called "ad hoc (ad-hoc)" networking.
[0017]A move computer is used together with the "base station" which makes it possible to often

exchange the computer and data of the others which maintain network connection along with the cable backbone in a building. In this case, since it may be assumed that a base station always has a lot of electric power and the electric power supply may be severely restricted to it as for the move computer, a base station mainly takes over a routing function. A base station participates in link layer routing in the form where he leaves that a move computer has access in all the move computers of a base station within the limits to each base station. When a move computer is within the limits of a base station, a base station is notified publicly of direct continuation nature by the periodic simultaneous transmissive communication of the adjacent station list. A base station may not carry out carrying out the simultaneous transmissive communication of the list which mobile station can cooperate, either, in order to create a data exchange course between the move computers of a different cell.

[0018]Since all the above-mentioned routing functions use link layer address specification technique (what is called "hardware address specification"), the above-mentioned method is almost applicable to the introductory equipment which uses a single physical media. The computer in a different network establishes and maintains the course for data exchange using network layer technique. The method of link layer routing written in this specification, Only in order to use it in the layer 3, it can also be made to suit by being able to use it together with such other techniques, or disregarding transmission of the protocol list of layers 3 in consideration of the address of the layer 3 instead of being an address of the layer 2 (namely, "hardware"). A single network-data course can be shown by a link layer, and two or more network-data courses can be processed by a network layer. The base station in a network facility has two or more responsibility of determining by which a required data path shall be established between a link layer and a network layer. When a base station is not included, a move computer uses chiefly link layer routing described on these specifications.

[0019]All the computers that carry out mutual operation in order to create a data path among these very thing are 1 time (.), for example to 1 time or several seconds in 1 second periodically. Or when the method of determining certainly is designed [that new simultaneous transmissive communication is required after all and], the simultaneous transmissive communication of the data requirement is carried out as it is needed. The data simultaneous transmissive communication by each move computer contains the routing table which has the following information at least about each address.

- The link layer address of an address.
- The number of hop (hop) required to reach an address.
- The time stamp of information in which the stamp was carried out by the address from the first and which was received about the address.
- ******** [wanting an address to work as a default router] (for example, an address is a base station). The transmitted routing table includes the hardware address of the move computer which transmits them by natural operation of link layer software. A routing table also contains again the time stamp created by the transmitting side. A specific move computer may also include the display which shows which base station has given one's service to each move computer within the same cell with the routing algorithm which is going to determine whether to be accessible or not.

[0020]If a move computer receives such a routing table, the computer will begin to update the routing table of itself memorized locally. Each received path updates all the existing courses which show the same address and the following hop. A time stamp is replaced with a new time stamp, the increment of the hop number shown in each received path is carried out, and it is memorized. The hop number in alignment with the course to arbitrary computers is called "the distance (metric)" about the course. The address of the transmitting side of a routing table is memorized as an address of the following hop along the course to an address. (The last) Furthermore it met the course to an address, it is not necessary to memorize other addresses. A new entry is assigned to the address when the course entry corresponding to neither of the existing address (address, the following hop) pairs is received. Since it is related with the computer which emitted the routing table transmitted, the entry of a local routing table is created or updated, the distance about the entry is set to 1 and a computer is reached, needing only one hop is shown. In other words, these two computers (the transmitting side and the receiver of a routing table) are "adjacent stations."

[0021]Each address has a limited number (few) of alternate routes specified with a different link layer address, respectively about the following hop in alignment with the alternate-routing course. Although the course which has an always more new time stamp as a standard for making a transmission decision

is chosen, it is not necessary to necessarily announce publicly (advertise). When an alternate route is otherwise possible, the course which has the shortest distance is memorized and other courses are forgotten. When it must choose between the alternate routes of the same distance, the course which has the newest time stamp is chosen. Since each move computer which transmits a local routing table carries out the stamp of each transmission with the local time value, almost all time stamps are emitted from a final destination. By the natural method spread by the routing table, a time stamp is chosen as each of other computer, and it can be determined that other computers of them maintain the routing entry about the move computer used as a starting point. When the move computer synchronizes, a time stamp is required only for one to the whole ad hoc community of a move computer.

[0022]Having stated above was only about the method of spreading and memorizing required routing data as a matter of fact. Details of the actual method of operating a routing table locally and updating it are given later. Data is used by two methods, the object for input packets, and the object for output packets. Operation of link layer routing will be best understood, if it thinks that it is carried out by the link layer and the thin protocol layer which is inserted between network layer protocols ("layer 3" in the stratification network term of International Organization for Standardization (ISO)) in a certain case. That is, link layer routing is performed after arbitrary high level protocol operations before other link layer operations about an output packet. About an input packet, link layer routing operation of this specification is performed before other high level protocol operations on the contrary after other link layer operations (for example, inspection of framing and data integrity).

[0023]About an output packet, link layer routing operation judges whether it is an adjoining computer, and a actual address when that is not right, The data which the link layer received is encapsulated and the new link layer header containing the packet type of a new destination address and the new layer 2 (link layer) is built. A new address is an address of the following hop along the course to a actual address. A packet type is a number on which it has agreed generally for starting the link layer routing procedure indicated here. That is, various processings of a new routing demand are started by the same method as an address decomposition protocol (ARP) requiring or high level protocol processing being started. Although the data which the link layer routing module received will be wrapped in a new packet type and a new address, that will not be right, but a packet is transmitted by the normal operation of a link layer.

[0024]If the packet which needs to be routed by such link layer operation at another address enters, the packet will be re-addressed by the following hop and will be sent to it. When the following hop is a actual address, a actual address and an actually required packet type are exposed by picking out the data of origin required for routing from a capsule, and discarding a capsule. When the following hop is not a actual address, except a packet type and a link layer header being changed into the address of the following hop with which the address on appearance met the course, it becomes remaining as it is and a checksum or a data integrity sign is updated if needed. In the computer which performs link layer routing in any case, activation of the protocol above a link layer is not carried out.

[0025]Drawing 2 shows the ad hoc network 10 which has the both-directions radio link 50 and the move hosts MH1 thru/or MH8. MH1 which moves to the position of the next door of MH7 and MH8 from the position of the next door of MH2 as a dotted line shows is shown. By this invention, a packet can be routed without communication with the base station of the fixed wired network among the move hosts of the network 10. Information required in order to route a packet via the network 10 is included in the table (shown later) maintained by each move host. These tables are updated so that the topology from which the network 10 caused by a move host's movement changes continuously may be reflected.

[0026]This whole concept is updating that routing table, when each move host is made to do the simultaneous transmissive communication of that routing table periodically and such simultaneous transmissive communication is received from an adjacent station corresponding to it. Thus, when each simultaneous transmissive communication is processed, all the move hosts build a perfect description of the present topology of the interconnection between all the move hosts who desire to establish an ad hoc network and who cooperate. The entry of each routing table is tagged with a time stamp, and the time stamp is used in order to solve some problems which accompany address vector algorithms, such as the Bellman Ford routing. Such an algorithm is efficient calculatively. To a desired address, a

course comes suddenly and the "best" distance is also chosen. "Distance" is the number of "hop" over which a packet must usually jump before reaching an address.
[0027]The course received in simultaneous transmissive communication is announced publicly by the receiver again, when carrying out the simultaneous transmissive communication of the routing information next, but. Since an input packet reaches an address and hop (namely, hop from the transmitting side to a receiver) is needed once again, a receiver adds increment to distance, before announcing a course publicly.
[0028]One of the most important parameters that should be chosen is the time of the interval which carries out the simultaneous transmissive communication of the routing information packet. However, if a move host receives the channel information corrected on new channel information or parenchyma, retransmission of the new information will be carried out immediately, and spread of the quickest routing information among all the move hosts who cooperate will be attained. This instant re-simultaneous transmissive communication introduces the new requirements that a protocol must converge as soon as possible. a move host's movement -- simultaneous transmissive communication -- oh, it will become a miserable thing, if ** happens and the usability of a radio medium falls.
[0029]A move host produces a destructive link, when moving to some places. A destructive link is expressed with an "infinite" (namely, bigger any value than maximum allowable distance) distance. When the link to the following hop is destroyed, an infinite distance is immediately assigned to all the courses which pass along the following hop, and the updated time stamp is assigned. Since it is considered that this is a substantial course change, in the routing information packet of simultaneous transmissive communication, such a correction course is indicated immediately. Construction of the information for describing a destructive link is in the only situation where a time stamp is created by arbitrary move hosts other than a destination moving host. When the move computer synchronizes, only one time stamp is required. The number of the time stamps created in order to be defined as the time stamp defined by the move host who is a source of release becoming even number and to show an infinite distance is odd. Thus, the time stamp of arbitrary "real numbers" replaces an infinite distance.
[0030]Probably in a very large move host group, adjustment is performed at the time in the intervals of the simultaneous transmissive communication of a routing information packet. Two types are defined in order to reduce the quantity of the information carried by these packets. One side is called a "total dump" and carries all the usable routing information. The type of another side is called an "increment type" and carries only the information which changed after the last total dump. The renewal of increment type routing is settled in one network protocol data unit (NPDU) by design. Also in the case of a comparatively small move host group, probably, two or more NPDU(s) are needed for a total dump. When a move host's movement does not take place, a total dump can be transmitted comparatively rarely. If movement becomes frequent and the size of increment approaches the size of NPDU, scheduling of the total dump (the following increment decreases like) can be carried out.
[0031]If a move host receives new routing information (with the above-mentioned increment type packet usually), the information is beforehand compared with available information from a front routing information packet. The course which has a newer time stamp is used. The course which has an old time stamp is canceled. When the course which has the same time stamp as the existing course has a "better" distance, the course is chosen, and an existing path is canceled, or it memorizes as a thing not desirable [so]. The increment of the distance of the course chosen from the newly received simultaneous transmissive communication information is carried out only one hop, respectively. Scheduling of the newly recorded course or the course which shows the improved distance is carried out so that the present move host's adjacent station may be notified publicly immediately.
[0032]The timing skew between various move hosts is expected. Even when a certain amount of regularity is expected, it is considered somewhat that the period in the intervals of the simultaneous transmissive communication of the routing information by a move host is an asynchronous phenomenon. In the agent group transmitted independently such, in order to update a course, some change may occur by using the above-mentioned procedure. Even when a destination moving host does not move, the problem that a specific move host receives new routing information by the pattern which coheres and to which the course to another following hop is changed from a certain following hop may arise. This is because there are what has two courses, i.e., a late time stamp, and a thing

which has a better distance about the new course which should be chosen. Although it is imagined that a move host receives two courses to the same address of having an always more new time stamp from the next (passing a different adjacent station) to the next, the course of a bad distance is always acquired at first. If not careful, this will cause the continuation burst of new course transmission for every time stamp new from the address. A new distance is spread to all the near move hosts, respectively, and the adjacent station spreads it to the adjacent station further, and it continues like the following.

[0033]The solution by the desirable example of this invention is that the public announcement of such a course is delayed, when a move host can judge, if the course which has a better distance is likely to appear soon. Although it must be usable in the course which has a late time stamp, unless it is a course to the address which was not able to reach before, it is not necessary to announce publicly immediately. therefore, it is for using the routing table held by each move host in those with two, and the method of one using it in forward packets, and another side is announced publicly via an increment type (and -- all) routing information packet. In order that arrival of the routing information which shows a better distance may judge near probability, a move host has to hold the history of the length which a specific course generally continues, before being updated by better distance.

[0034]Even if all the above-mentioned procedures are performed by which of the network layer (layer 3) of a protocol stack, and a link layer (layer 2), they are effective. Therefore, transmission can be carried out in the layer 2 with packet simultaneous transmissive communication to provide the ad hoc network of the move host who can communicate using some possible pro Kotor of the layer 3. In service of two corner points which did not carry out pro Kotor of the same layer 3 as a middle move host thereby, for example, a middle move host can transmit a packet now.

[0035]The address memorized by the routing table corresponds to the layer in which this ad hoc network protocol is carried out. That is, the operation in the layer 3 uses the network layer address and destination address for the following hop, and the operation in the layer 2 uses the media-access-control (MAC) address of the layer 2.

[0036]However, new requirements will be introduced if a MAC Address is used for a transfer table. Although layer 3 network protocol realizes communication based on three network addresses to have been troubled, the method of decomposing these layer three addresses into a MAC Address must be provided. Otherwise, the address decomposition mechanism from which a large number differ is established, and when using the decomposition mechanism, the loss of bandwidth corresponding in a radio medium will always be accepted. This is important and this is because such a mechanism will need the simultaneous transmissive communication and retransmission simultaneous transmissive communication by all the move hosts of an ad hoc network. All address solutions look like the bad condition in network standard operation. Therefore, if special attention is not paid, does every activity user understand it clearly?

[0037]The solution by this invention is including layer 3 protocol information about the operation in the layer 2 in addition to the routing information of the layer 2. Each move host who announces publicly whether each destination host supports the protocol of layer 3 throat, and announces the reachability to an address publicly will include the information about layer 3 protocol supported by an address other than the public announcement. What is necessary is to transmit this information, only when it changes, and it rarely happens. This information will be transmitted as a part of each "total-dump." Since each move host can support layer 3 protocol [some (or large number)], the length of this list must be variable.

[0038]The structure of the course entry in the internal transfer table maintained by each move host in the network 10 shown in drawing 2 is shown in Table 1.

[0039]

[Table 1]

destination address protocol dependence size -- hop [next] address Protocol dependence size distance Integer time stamp without numerals ; from an address -- integer installation time without numerals Device dependence (for example, 32 bits)

Pointer to stability data Pointer to device dependence protocol data Only device dependence and layer 2[0040]For example, the move host 4 in drawing 1 is examined. Each move host's address is expressed with MHX, and it is assumed that all the move hosts are supported by Internet Protocol (IP). It is

assumed that all the time stamps are furthermore shown by TNNN_MHX. This MHX specifies the computer which created the time stamp, and TNNN is a value of time. Before the move host 1 moves from the move host 2, it is assumed that other move hosts of all the have an entry which has the time stamp TNNN MHX. At this time, the internal transfer table in MH4 is as follows (I would like to be minded by that a line corresponds to various move hosts and a sequence deals with the data described with said structure).

[0041]

[Table 2]

address The following hop Distance time stamp introduction . flag . Stable data protocol data MH1 MH2 2 T406_MH1 T001_MH4 PTR1_MH1 PTR2_MH1MH2 MH2 1 T128_MH2 T001_MH4 PTR1_MH2 PTR2_MH2MH3 MH2 2 T564_MH3 T001_MH4 PTR1_MH3 PTR2_MH3MH4 MH4 0 T710_MH4 T001_MH4 PTR1_MH4 PTR2_MH4MH5 MH6 2 T392_MH5 T002_MH4 PTR1_MH5. PTR2_MH5MH6 MH6 1 T076_MH6. T001_MH4 PTR1_MH6 PTR2_MH6MH7 MH6 2 T128_MH7 T002_MH4 PTR1_MH7 PTR2_MH7MH8 MH6 3 T050_MH8 T002_MH4 PTR1_MH8 PTR2_MH8[0042]From now on, since the installation time of almost all computers is almost the same, all the computers will be presumed for the almost same time to have come usable for MH4, for example. Since unit position has even time, all the time stamp fields are presumed that one link between computers was not destroyed, either. Since there is no course to the specific destination which is likely to replace or compete in other courses in drawing 1, all PTR1 MHX serves as a pointer to null structure. All protocol-data pointers point out the structure of having the following formats. protocol ID=IP, protocol address length =4 byte, and protocol address = [MHX.Net.addr.ess] -- here, MH1.Net.addr.ess, It is 4 bytes of IP address about MH1 displayed in a standard Internet4 octet form.

[0043]Table 3 shows the structure of the course entry in the route table announced publicly.

[0044]

[Table 3]

destination address Protocol dependence size distance Integer time stamp without numerals ; from an address -- an integer without numerals -- size of the next layer three address 8 bits and 8 bits of protocol ID of the next address which is not already at the time of 0 -- address of the layer 3 following protocol[0045]The last item appears, only when the ad hoc algorithm operates in the layer 2. Since all the public announcements are suggested the following hop, it is not necessary to list. It is assumed that operation is performed in the layer 2, and a move host has address X:X:X:X:X:X, therefore a move host has MAC Address 1:1:1:1:1:1 (the standard format showed). Furthermore, it is assumed that IP is shown as what has protocol ID7 of the layer 3. Corresponding to it, it is assumed that the move host's MHX Internet address is expressed as X.X.X.X. Then, in the above-mentioned situation, the course announced publicly is expressed as follows.

[0046]

[Table 4]

Address Distance Time stamp Length ID. Layer three address length 1:1:1:1:1:1 2 T406_MH1 4 7 1.1.1.1 02:2:2:2:2:2 1 T128_MH2 4 7 2.2.2.2 03:3:3:3:3:3 2 T564_MH3 4 7 3. 3.3.3 04:4:4:4:4:4 0 T710_MH4 4 7 4.4.4.4 05:5:5:5:5:5 2 T392_MH5 4 7 5.5.5.5 06:6:6:6:6:6 1 T076_MH6 4 7 6.6.6.6 07:7:7:7. :7:7 2 T128_MH7 4 7 7.7.7.7 08:8:8:8:8:8 3 T050_MH8 4 7 8.8.8.8 0[0047]Here, the move host 1 moves around the move hosts 5 and 7, and it is assumed that it separated from other move hosts (especially move host 2). The new internal transfer table in the move host 4 is as follows.

[0048]

[Table 5]

address The following hop Distance time stamp introduction . flag . Stable data protocol data MH1 MH6 3 T516_MH1 T810_MH4 M PTR1_MH1 PTR2_MH1MH2 MH2 1 T238_MH2 T001_MH4 PTR1_MH2 PTR2_MH2MH3 MH2 2 T674_MH 3 T001_MH4 PTR1_MH3. PTR2_MH3MH4 MH4 0 T820_MH4. T001_MH4 PTR1_MH4 PTR2_MH4MH5 MH6 2 T502_MH5 T002_MH4 PTR1_MH5 PTR2_MH5MH6 MH6 1 T186_MH6 T001_MH4 PTR1_MH6. PTR2_MH6MH7 MH6 2 T238_MH7 T002_MH4 PTR1_MH7 PTR2_MH7MH8 MH6 3 T160_MH8 T002_MH4 PTR1_MH8 PTR2_MH8[0049]Although only the entry of MH1 shows a new distance, many new time stamp entries are received at the time of a between. That is, the first entry must be announced publicly in renewal of the increment routing information which will happen continuously by the time it has the flag M (M of the distance Metric) and the following total dump

arises. When the move host 1 moved around the move hosts 5 and 7, the renewal of instancy of increment type routing information was started. The simultaneous transmissive communication of this was carried out to the move host 6 after that. The move host 6 judged that important and new routing information was received, and updating was started the instancy which carries the new routing information about the move host 1 to the move host 4. When the move host 4 receives this information, he will do the simultaneous transmissive communication of it at all the intervals to the total dump of the following routing information. In the move host 4, the renewal of increment type public announcement routing has the following forms.

[0050]

[Table 6]

address . distance . Time stamp 4 4 4 4 4 4 0 T820_MH41 1 1 1 1 1 3 T516_MH12 2 2 2 2 2 1 T238_MH23 3 3 3 3 3 2 T674_MH35 5 5 5 5 5 2 T502_MH56 6 6 6 6 6 1 T186_MH67 7 7 7 7 7 2 T238_MH78 8 88 8 8 3 T160_MH8 [0051]In this public announcement, since the move host 4 is announcing publicly, the information about the move host 4 becomes the beginning. Since it is only one thing that has an important path change which has influence since the move host 1 has a low address not but, the information about the move host 1 becomes the next. The whole renewal of increment type routing has the following forms.

[0052]

[Table 7]

Transmitted data Course in which the course time stamp in which the route distance by which the protocol availability information on a "local station address" and distance ** 0 horizon 3 was changed was changed was changed [0053]There is no move host who changed layer 3 protocol structure in this example. Since there was a computer in a new position, the routing information was changed. All the computers transmitted a new time stamp to the newest. When there are too many updated time stamps and they are not settled in a single packet, only the settled time stamp is transmitted. These are chosen in order to transmit impartially covering some increment renewal intervals.

[0054]Such a format is not required for transmission of all the routing information packets. A required number of packets are used and all usable (including required layer three address information) information is transmitted.

[0055]In order to process operation of some of time dependency within an ad hoc network protocol, a standard event list structure must be maintained. The example of a node may be as follows.

[0056]

[Table 8]

Event time phenomenon discernment phenomenon data (pointer to a course entry)

[0057]An event list is inspected when the clock of a computer carries out a clocking. When the first node expires, a phenomenon node is pulled out from a list, the discernment used in order to call correction procedure, and the phenomenon data handed over as an argument to a phenomenon manipulation routine.

[0058]The following explanation explains the directions at the time of preventing change of a routing table entry about the waiting waiting time table for stability. Since the renewal of a course is chosen in accordance with the following standards, a general problem produces it.

- When a time stamp is newer, the course is always preferred.
- Otherwise, although a time stamp is the same, the course is preferred when distance is better (short).

In order to understand a problem, it is assumed that the move host received in the order which made a mistake in two courses of having a discernment time stamp. That is, it is assumed that the move host 4 receives the following hop of a long distance by the beginning, and gets another following hop of distance with a time stamp short similarly just after that. This is not so regular, and when there are many move hosts who transmit updating, it may happen. Instead, when the move host is completely operating independently with a remarkably different transmission interval, corresponding to it, this situation may happen by fewer hosts. Anyway, in drawing 3, although both are connected to common address MH9, other move hosts assume that there is sufficient move host to cause this problem into two separate move host groups which are not common. It is assumed that all the move hosts are transmitting updating every about 15 seconds, move host MH2 has a course of 12 hop to MH9, and

move host MH6 has a course of 11 hop to MH9. It is assumed that the renewal of the routing information from MH2 reaches MH4 about 10 seconds ago rather than renewal of the routing information from MH6. This is performed whenever a new time stamp is published from move host MH9. So that it may happen, when not settled in renewal of the increment packet with all the single hosts which has too many hosts who have the new renewal of a time stamp actual, for example, A time lag can become severe when the arbitrary move hosts of the group II begin to publish the renewal of a time stamp with two or more increment type renewal intervals. Generally, it is expected that the difference of the updating delivery in drawing 3 becomes severe, so that a hop number becomes large.
[0059]Stable waiting time data is memorized on the table which is specified by the first two fields and which has the following forms.
[0060]
[Table 9]
The destination address following hop address last stable waiting time average stable waiting time
[0061]It is assumed that renewal of new routing information reaches the move host 4. The time stamp of a new entry is the same as the time stamp in the entry used now, and a newer entry has a worse (that is, longer) distance. Then, if the move host 4 does not use a new entry when he makes the next transmission decision, he learns, and he is **. However, the move host 4 can investigate the stable waiting time table of the course, in order to decide for which it waits before not announcing a new course publicly immediately and announcing it publicly. Average stable waiting time is used for this determination. For example, before announcing a course publicly, the move host 4 can determine to be delayed (average stable waiting time *2).
[0062]This is a dramatically useful thing. It is because this bad result will probably be repeated whenever that result will spread via a network and renewal of the time stamp of move host MH9 will spread via an ad hoc network, if a course with an unstable possibility is announced publicly immediately. On the other hand, when the link which goes via move host MH6 breaks truly, the course which goes via MH2 should be announced publicly immediately. In order to attain this, when move host MH4 has a history of change, link destruction should be enough detected early so that the middle host in the group II may discover a problem and the renewal of increment which shows an infinite distance about the course along the course to move host MH9 and by which the trigger was carried out may be started. That is, it seems that the problem has other effects which govern enough time path update patterns to make powerless the mechanism in which change is avoided when a problem similar to change of renewal of routing which took place before appears. The course which has an infinite distance must be immediately announced publicly by definition.
[0063]In order to bias a damping mechanism in favor of the newest phenomenon, the newest measured value of the stable waiting time of a specific route must be counted by a bigger load factor than old measured value. And before it is considered by the important thing truly that a course is a stable state, the parameter with which which shows whether it must be a stable state must be chosen as it. This will specify the maximum of stable waiting time of one pair of addresses (an address, the following hop) in a stable waiting time table after all. A course more stable than the course which has this maximum causes updating by which the trigger was carried out to the case where it is replaced in another course which has the following hop or distance from which it differs.
[0064]Although the way link layer software carries out routing table management is common knowledge, some details are shown about an embodiment specific for explanation. This table itself is an array of the fixed size entry often statically assigned by the data memorized in the data memory of an operating system so that that might be right. Each entry has an integer field which specifies the "next" entry, and, thereby, becomes like access of the list which access to the routing table of the normal mode twisted and (it is an everyday occurrence when it is the array the size was statically decided to be) linked to linear search. Each destination node can have at most three alternate route. These courses carry out an optimal path first, and are memorized as three continuous elements of a list. When the shown optimal path goes wrong or it is judged that the data is out of condition, the following course "being promoted (promoted)" actually.
[0065]When the new renewal of routing is thought that updating is applied to a table from an "adjacent station" between said, processing for deleting an entry out of condition is also performed. An entry out of condition is defined as the entry to which updating was not applied within the update period of latest

23. Since it is expected that each adjacent station sends updating periodically, if updating is not received for a while, a receiver may judge that a corresponding computer is not an adjacent station any longer. If it happens, every course which uses the computer as following hop will be deleted including the course which shows the computer as a actual address (once contiguity). When there are many update periods generated before an entry is determined, the number of routing entries out of condition will increase, but a transmission error also increases. Although a transmission error is being often in the case of many radio embodiments, a possibility of generating also when using a CSMA type simultaneous transmissive communication medium is high. When a link breaks, scheduling of the course of an infinite distance should be carried out to the course depending on the link and its link.
[0066]A time-out procedure when judged with data of drawing 4 being out of condition is shown. First, with the functional block 40, a course entry is obtained from event list data, and, subsequently a course is deleted from an internal table with the functional block 41. An infinite distance is inserted in the table of the course announced publicly with the functional block 42, and then the examination for which the address judges whether it is the following hop of other addresses by the judgment blocks 43 is done. When that is right, it is the functional block 44 and the course of an infinite distance is announced publicly to the address which cannot be reached now. As shown in drawing 5, "ADVERTISE" phenomenon processing includes the processing which inserts the course specified as the route list announced publicly with the functional block 45, and the processing which subsequently sets an INCREMENTAL flag with the functional block 46. Simultaneously, a SHOWN YET flag is reset. The course inserted will show a distance infinite to an address.
[0067]Drawing 6 shows the logic of renewal transmission of an increment type from a move host. This processing begins from the functional block 47, and change of protocol availability is inserted. Subsequently, a public announcement route list is scanned with the functional block 48, FLAGS and SHOWN YET are 0 in the judgment blocks 49, or an inspection is conducted. If this condition is suited, with the functional block 50, that course will be inserted and a flag will be set. Next, an examination is done by the judgment blocks 51 and it is judged whether an output packet is too full. When too full, before processing finishes, scheduling of the total dump is carried out with the functional block 52, when that is not right, it returns to the functional block 48 and a public announcement route list is scanned.
[0068]Even if a public announcement route list is scanned, an examination is done by the judgment blocks 53 and it is judged whether FLAGS and INCREMENTAL are 0. When it is 0, processing returns to the functional block 48, and when that is not right, the course is inserted with the functional block 54. An examination is done by the judgment blocks 55 and it is judged whether output PAKKETO is too full. Scheduling of the total dump is carried out with the functional block 52, when too full, when that is not right, a public announcement route list is again scanned with the functional block 56, but it begins from LAST ADVTIMESTAMP at this time. When a public announcement route list is scanned, an examination is done by the judgment blocks 57 and it is judged whether FLAGS and NEW TIMESTAMP are 0. When it is not 0, a course is inserted with the functional block 58, an examination is done by the judgment blocks 59, and it is judged whether an output packet is too full. When too full, it is set to the last course in which LAST ADV TIMESTAMP was shown by the functional block 60, and when that is not right, LAST ADV TIMESTAMP is set to zero with the functional block 61, and processing is completed.
[0069]Drawing 7 shows the logic of total-dump transmission from a move host. First, an examination is done by the judgment blocks 62, and it is judged whether any course is shown. When not shown, before processing finishes, it is the functional block 63, and increment transmission is performed and scheduling of the total dump is carried out again. When that is not right, it is the functional block 64 and all usable protocols are inserted according to the specified table format. Next, the "FLAGS" field where all public announcement courses are inserted with the functional block 65 according to the form of a table is deleted. Finally, with the functional block 66, increment is reset in all the public announcement courses, and processing is completed.
[0070]Drawing 8 shows the logic of the total-dump processing at the time of reception. Input data is first scanned with the functional block 67, and a course is new in whether a time stamp is new at the judgment blocks 68 at the judgment blocks 69, or it is judged whether it has a new distance and whether one of protocols were changed by the judgment blocks 70 again. When a time stamp is new, it

is the functional block 71, and the present value is put on the inner path appointed table, scheduling of the timeout phenomenon is carried out again, and new timeout is marked in a table. Next, with the functional block 72, measurement of the stable waiting time of the course is started, and processing is completed. On the other hand, a course is new, or when it has a new distance, it is the functional block 73 and scheduling of the error activity is carried out. Subsequently, with the functional block 74, stable waiting time is updated and processing is completed. On the other hand, when one of protocols change, layer 3 suitable activity is changed for example, using ARP table management with the functional block 75.

[0071]Drawing 9 shows the increment type update process at the time of reception. . [whether input data was scanned with the functional block 76, and protocol availability was changed by the judgment blocks 77, and] It is judged whether a time stamp is the same at the judgment blocks 80 in whether a time stamp is old in whether a course is new at the judgment blocks 78 at the judgment blocks 79, and distance is shorter. When protocol availability is changing, suitable layer 3 manipulation routine is called with the functional block 81, and it progresses to the judgment blocks 78. When a course is new, scheduling of the renewal of output increment is carried out with the functional block 82, and processing is completed. When a time stamp is old, an examination is further done by the judgment blocks 83, and a course judges whether it has an infinite distance. When a course does not have an infinite distance, it is canceled with the functional block 84 and processing is completed. When a course has an infinite distance, a SHOWN YET flag is reset with the functional block 85, and processing is completed. When a time stamp is the same and distance is shorter, the present stable waiting time is updated with the functional block 86, and it is first put into an entry new on a public announcement list with the functional block 87. Next, with the functional block 88, a SHOWN YET flag is reset, increment is set, a related "ADVERTISE" phenomenon is deleted, and processing is completed. It returns to the judgment blocks 80, when a result is denial, it progresses to the functional block 89, and the course entry in an internal table is used, and timeout is reset. Next, with the functional block 90, scheduling of the recovery is carried out after the present evaluation of stable waiting time, and processing is completed.

[0072]After stable waiting time passes over drawing 10, it shows the flow chart for inserting a course in a public announcement course. This processing will start, if the recovery timer set with the functional block 90 of drawing 9 sounds with the functional block 101. If this happens, it will be judged whether it is the same as the course on which the examination was done by the judgment blocks 102 and which was notified publicly of the established course. When the same, it is not necessary to perform anything and processing is ended. However, when it differs, before SHOWN YET is reset with the functional block 103 and processing finishes, scheduling of the following renewal of increment is carried out with the functional block 104.

[0073]There is a data field of the addition transmitted as a part of each entry in the routing table by which simultaneous transmissive communication is carried out by each computer (a mobile station or a base station) which involves besides the above. These fields are decided with other protocols for which it depends on operation of a high level protocol or a link layer, for example. For example, in order to enable right ARP operation, each routing table entry may also have to include the Internet Protocol (IP) address corresponding to a destination address. When using a routing function for an adjacent station, this is performed in order to make a middle computer usable, and publishes "Proxy ARP" instead of routing of ARP simultaneous transmissive communication.

[0074]The false C code which is used in order to attain an ad hoc network among the move hosts who cooperate and which describes various procedures is listed below.

[0075]

```
struct forwarding route entry{
 address t destination;

 address t next hop;
 value t metric;
 value t settling time;
 value t install time;
 protocol list;
 flags;
}
/*
```

This table is initialized so that the data about the move host who performs these procedures may always be included.
* /struct advertised. route. entry{address t destination; value t metric; proto ptr protocol list;struct advertised route entry *advertised route table {= myaddress, 0,my protocol list};struct protocol list {value t protocol type; value t address size; u char[] layer3 address ;}/** each move host has to maintain two tables of a course entry.
* – Course *//** each move host used for the course entry *–transmission announced publicly has to maintain the phenomenon Li * strike which has a node about various kinds of possible timeout phenomena. The possible phenomenon is as follows.
* * which times out – routing table entry – In order to avoid change which may take place, course * to the public announcement table by which the public announcement was delayed is added.
* carry out the simultaneous transmissive communication of the – public announcement periodically (an increment type -- or -- all).
*/Timeout(){get event from list(); switch (event type) case ROUTE TIMEOUT: bad route=event type->routeif; (.) bad route->metric=1 / * ****, */ for (route.) from which the adjacent station died =. first; . For all the courses in a /* table. It attaches and is */){if route->next hop = bad route){rOute->metric = INFINITE METRIC; route->flags = METRIC CHANGED;route->timestamp. | =1;} bad route->flags.} l=METRIC CHANGED bad. route->metric=INFINITE. METRIC;. bad route->timestampl=1; . /*. */ do incremntal(); break; case ADD ADVERTISEMENT: route->flags l=CHANGED; break; case DO ADVERTISEMENT:if (.) which carried out the increment only of 1 full dump scheduleddo full dump();else do incremental(); break;}}struct settling time table{address t de stination; time t settling. time;. value t number of next hops; addr list next hop list;}struct next hop list{address t next hop; list ptr *next hop list;}. do full dump(){get empty. NPDU()for; (.) A /* public announcement Each course */) {copy route into NPDU() if (NPDU full) (transmit NPDU(); get empty NPDU();} route->flags &= /* change in the routing table carried out. A bit. */NOT (CHANGED.) to reset l CHANGED PROTOCOL l CHANGED METRIC;} A */ schedule full dump(USUAL PERIOD);}/** incremental dump to be taken notice of by that local station data was automatically contained by the /* above, Some following portions are piled up.
* The entry about – transmitting station (namely, this move host).
* – Entry about move host * which corrected a new move host or layer 3 protocol availability information.
* The entry about the new move host by whom – routing information was changed on parenchyma.
* – Entry only reflecting a new time stamp.
* An increment packet is restrained so that it may fit only in one layer 3 packet (network protocol data YU * knitting). The place * ** too much important change is to report must carry out scheduling of the total dump. renewal of a time stamp -- * -- pursuing the renewal of a time stamp reported at the end, when too large to report -- * next time -- and it starts.
* /do incremental dump(){get empty NPDU(); the new time stamp of a local station is transmitted to the /* beginning. Distance 0*/ if (.) route to myself->timestamp. & 0x00000001! =0 printf. ("unexpected internal time stamp error**r**n"); route to myself->timestamp = route to myself +2;copy route into NPDU(route to myself) for () route=first;. Each course */) if (route->flags & PROTOCOL

CHANGED) copy route into NPDU(route) if (NPDU full) (schedule full dump(in a /* public announcement routing table IMMEDIATE;. each course */in a printf (Unexpectedly full incremental!¥n"); transmit NPDU(); get empty NPDU();}} for (route=first;/* public announcement routing table {. if (route->flags & ALREADY DONE) continue; /*. This above already. Shown */ if (route->flags & METRIC CHANGED) copy route into NPDU(route) if (NPDU full) (schedule full dump(IMMEDIATE);. printf("not expecting all the increment incremental!**n"); for (route=last timestamp shown;.) transmit NPDU(); get empty NPDU();}} /* */{if (route->flags.) & ALREADY DONE continue; . This by the /* above already. Shown */ if (route->flags & TIMESTAMP CHANGED) {copy route into NPDU(route) last timestamp shown = route;} if (NPDU full) (.) break; */} which stops construction of a /* increment packet If a transmit NPDU();}/** move host receives routing information from one of adjacent stations,} It is [whether each * course entry of a packet is investigated and the inner path appointed table is updated, and] ****** * **. when an input packet is a total dump, different information on parenchyma is usually expected -- * -- there is nothing. the case where it has a but more short distance in which newness is equivalent when newer -- * -- a new course is accepted.

* When * input route is accepted based on the standard of a newer time stamp, determine [whether * and a new course are announced publicly and]. It depends for this determination on history * of the past of the course acquired from the transmitting side (namely, the following hop) of the packet about specific address move Hoss * TO.

* * to be taken notice of by that only 1 must carry out the increment of the distance the course which passes along * next hop was indicated to be about the input * courses in which only one hop is more arbitrary than the course to the following hop since it reflects becoming long (since it is the hop from this move host to following hop *).

Each entry in a */process incoming route update(){must schedule incremental = FALSE; for (new route=packet data; /* packet. */{old route = find(new route,route table); new route->metric =new route->metric +1; if (new route-> to perform timestamp > old route->timestamp) {new route->timeout = calculate timeout(new route); replace (old routej new route);. route table); delete timeout event (old route); schedule timeout event (new route); if (new route-> type & CHANGED PROTOCOL){must schedule incremental = TRUE; new route->flags I=CHANGED PROTOCOL; new route-> install time = current time();} else if ((new route->type & CHANGED METRIC) II (new route->metric <old route->metric { must schedule incremental = TRUE; new route->flags I=CHANGED METRIC; new route-> install time =current time();} else if (new route->metric >= old route->metric) {stable time = check settling time (.)newroute if (0 ==stable.) time /* -- it. */ new route->flagsI= CHANGED; else enter event list(new route, stable time,ADD ADVERTISEMENT);}} else if ((new routeto announce publicly ->timestamp == old route->timestamp&& (new route->metric < old route->) metric)) {enter settling time data (old route, new route); new route->timeout = calculate timeout(new route);. replace (oldroute, new route, route table); delete timeout event (old route); schedule timeout event (new route);. new route->flags I=CHANGED METRIC; new route->install time = current time();}} if (must schedule incremental) {schedule incremental(IMMEDIATE); . if (incoming packet->packet type ==FULL DUMP) In order to weaken printf;("Full dump has new, unreported data!¥r¥n")}}/** change, The data about the frequency of course change is held. Although a course public announcement is received in a certain situation by the specific move host who has * and the same time stamp, it is possible that receive by an "order * foreword blank", namely, two courses of having the same time stamp short * Are more, and distance is reached first.

* Last stability waiting time * average stability waiting time *2 ** data is held.

* Average stable waiting time ** * Obtains those results, and a pre- average is increased 16 times, and the present value is doubled, and it is calculated by dividing it by 18. This is effective in few * Using the newest result and giving big dignity to it rather than 16 front results.

* /enter settling time. (new route, old route) {route. data = find (.) new. route->destination, old route->next hop, settling time table); settling time = (16* route data->settling time) + 2* (current time. () - old route->install time); settling time = settling time ¥ 18;}check settling time (new route){route data = find (new route, settling time table); settling time data =route data->settling time; if (settling time data == NULL)return 0if; (.) settling time data > MAXIMUM DELAYreturn 0;else ret. urn (settling time data);

[0076]Although this invention was explained based on one desirable example, it will be understood by the person skilled in the art that this invention can be corrected and carried out by the meaning of an

attached claim and within the limits. The new routing algorithm of this invention is developed in order to enable creation of the "ad hoc network" especially needed for operation of a move computer most dramatically. However, operation of this routing algorithm itself and an "ad hoc network" can be advantageously used also in the situation where a move computer is not included. For example, this routing algorithm is applicable to the situation of needing few (comparing with a link condition routing algorithm) memory requirements. Operation of an "ad hoc network" is applicable not only to a radio move computer but a cable move computer. Therefore, generally, this invention provides the new order routing algorithm of an address, and it is compensated with this algorithm by the technique which weakens change.

[0077]As a conclusion, the following matters are indicated about the composition of this invention.

[0078](1) Between two move hosts combined with the ad hoc network which comprises two or more move hosts who do not have a fixed position although it has a peculiar network address, respectively, In [are the method of routing the information on a packet, and] each move host, The stage of memorizing a routing table including the "distance" defined as a hop number from a sauce move host to a destination moving host, With the stage which announces a course publicly when the move host does periodically the simultaneous transmissive communication of the routing table memorized by each move host, and the time stamp emitted from the destination moving host. The stage which tags the entry of each routing table, and the stage which updates the routing table memorized by the move host for every destination moving host based on the simultaneous transmissive communication received from other move hosts, A method including the stage which chooses the course for transmitting the information on a packet from a sauce move host as the stage which carries out retransmission of the new routing information which each move host received from the contiguity move host, and a course which has the best "distance" about a desired destination moving host.

(2) The routing method given in the above (1) characterized by performing routing by the link layer of an ad hoc network according to the network standard in which an ad hoc network contains a network layer and a link layer.

(3) A shorter distance or an infinite distance is defined as the course which it has by the new course, and it an infinite distance, Express the destroyed link, namely, it becomes impossible for a specific address to reach, Therefore, it means that attainment of all the addresses of the others depending on the address in which this new attainment is impossible becomes impossible in itself, The routing method given in the above (1), wherein the immediate execute of said stage which carries out retransmission of the new routing information received from the contiguity move host is done by the move host at the time of reception of new routing information.

(4) By determining the average stable waiting time of the stage of holding the data about the frequency where the course memorized by said routing table changes, and the course memorized by said routing table, The stage which measures the stability of a course, and the stage of memorizing the stable waiting time of the measured course on a stable waiting time table, The routing method given in the above (1) which accesses on a stable waiting time table before a public announcement stage, delays the public announcement of the course which may change soon, and includes further the stage which weakens change of the information in said routing table by that cause.

(5) The routing method given in the above (4) which includes further the stage of performing weighting in the course stable waiting time measured by counting the newest measured value of the stable waiting time of the specific course which has a bigger load factor than old measured value.

(6) The stage where an ad hoc network memorizes routing information to said routing table further based on a move host's network layer address, By determining the average stable waiting time of the stage of holding the data about the frequency where the course memorized by said routing table changes, and the course memorized by said routing table, The stage which measures the stability of a course, and the stage of memorizing the stable waiting time of the measured course on a stable waiting time table, The routing method given in the above (1) which accesses on a stable waiting time table before a public announcement stage, delays the public announcement of the course which may change soon, and includes further the stage which weakens change of the information in said routing table by that cause.

(7) The stage of memorizing routing information to said routing table based on a move host's link layer address, By determining the average stable waiting time of the stage of holding the data about the

frequency where the course memorized by said routing table changes, and the course memorized by said routing table, The stage which measures the stability of a course, and the stage of memorizing the stable waiting time of the measured course on a stable waiting time table, The routing method given in the above (1) which accesses on a stable waiting time table before a public announcement stage, delays the public announcement of the course which may change soon, and includes further the stage which weakens change of the information in said routing table by that cause.
(8) The routing method given in the above (1) which includes further the stage which pursues network layer protocol availability data for every address.
(9) It comprises two or more move hosts who do not have a fixed position although it has a peculiar network address, respectively, Including a network layer and a link layer between two move hosts combined with the ad hoc network according to a network standard, In [are the method of routing the information on a packet, and] each move host, The stage of memorizing a routing table including the "distance" defined as a hop number from a sauce move host to a destination moving host, With the stage which announces a course publicly when the move host does periodically the simultaneous transmissive communication of the routing table memorized by each move host, and the time stamp emitted from the destination moving host. Based on the stage which tags the entry of each routing table, and the simultaneous transmissive communication received from other move hosts, It is a stage which updates the routing table memorized by the move host for every move host, Said updating is limited to the new course defined as the course which has a better distance or an infinite distance, The updating stage meaning attainment of all the addresses of the others which an infinite distance expresses a destructive link, namely, it becomes impossible for a specific address to reach therefore, and are dependent on the address in which this new attainment is impossible becoming impossible in itself, The retransmission stage which is a stage where each move host does retransmission of the new routing information received from the contiguity move host, and will be immediately performed if a move host receives new routing information, A method including the stage which chooses from a sauce move host the course which transmits the information on a packet as a course which has the shortest "distance" about a desired destination moving host.
(10) By determining the average stable waiting time of the stage of holding the data about the frequency where the course memorized by said routing table changes, and the course memorized by said routing table, The stage which measures the stability of a course, and the stage of memorizing the stable waiting time of the measured course on a stable waiting time table, The routing method given in the above (9) which accesses on a stable waiting time table before a public announcement stage, delays the public announcement of the course which may change soon, and includes the stage which weakens change of the information in said routing table by that cause.
(11) The routing method given in the above (10) which includes further the stage of performing weighting in the course stable waiting time measured by counting the newest measured value of the stable waiting time of the specific route which has a bigger load factor than an old phenomenon.

[Translation done.]

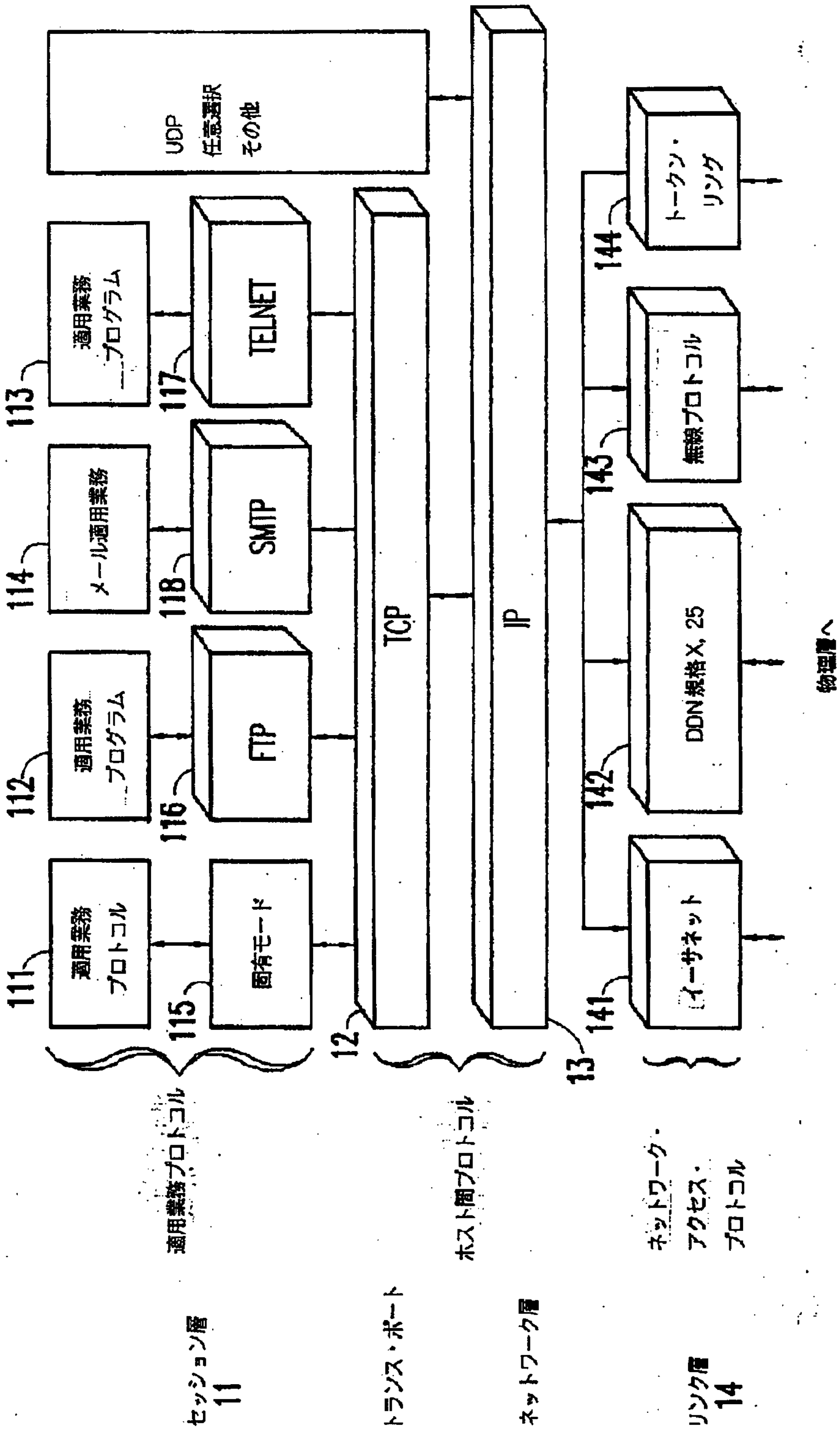
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is an architecture figure of Defense Data Network.
[Drawing 2]It is a functional block diagram of the "ad hoc" network which consists of two or more radio move hosts.
[Drawing 3]It is the functional block diagram which was connected to the common address and in which showing two separate move host groups.
[Drawing 4]It is a flow chart showing the logic of a timeout procedure.
[Drawing 5]It is a flow chart showing the logic of "ADVERTISE" phenomenon processing.
[Drawing 6]It is a flow chart showing the logic of renewal transmission of an increment type.
[Drawing 7]It is a flow chart showing the logic of total-dump transmission.
[Drawing 8]It is a flow chart showing the logic of the total-dump processing at the time of reception.
[Drawing 9]It is a flow chart showing the logic of the increment type update process at the time of reception.
[Drawing 10]It is a flow chart showing the logic which inserts a course in a public announcement course after progress of stable waiting time.
[Description of Notations]
1 Move host
2 Move host
3 Move host
4 Move host
5 Move host
6 Move host
7 Move host
8 Move host
10 Ad hoc network
50 Bidirectional radio link

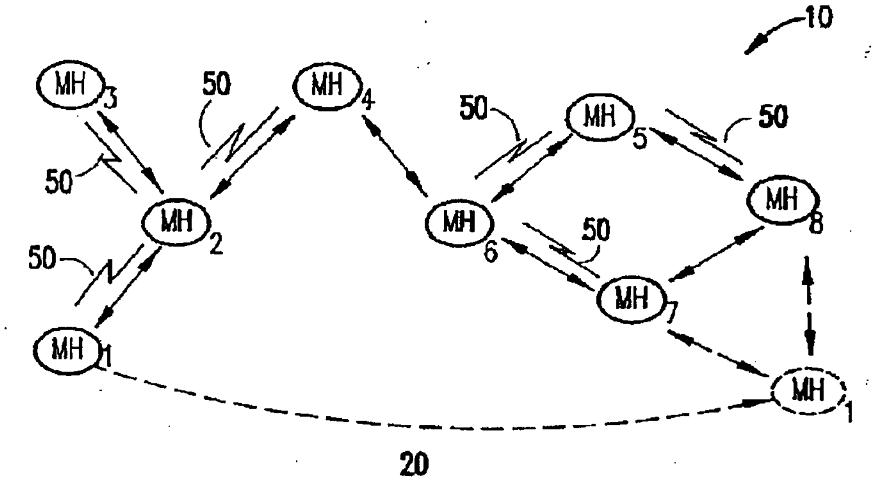
[Translation done.]

DRAWINGS

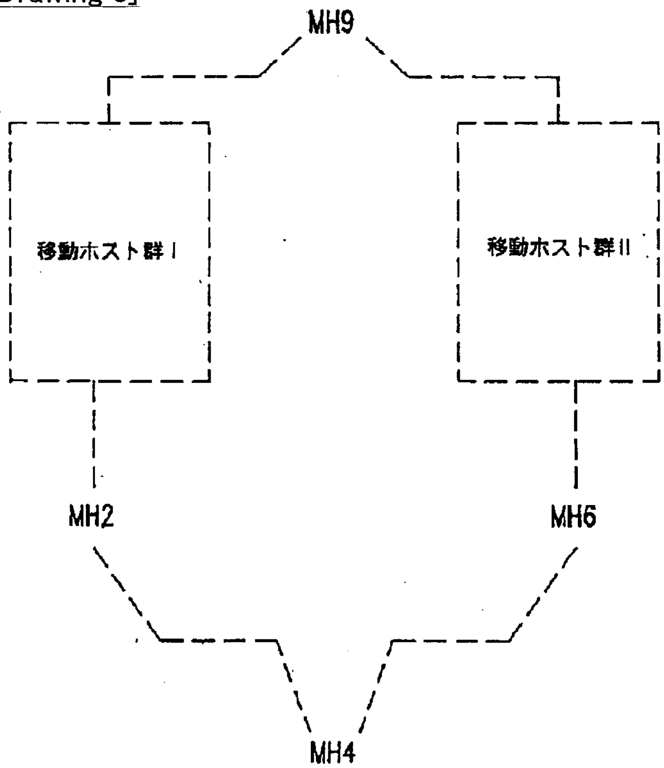
[Drawing 1]


UDP
任意選択
その他
適用業務
プログラム
TELNET
メール適用業務
SMTP
適用業務
プログラム
FTP
適用業務
プロトコル
固有モード
TCP
IP
トークン・
リング
無線プロトコル
DDN規格X, 25
イーサネット
物理層へ
111
112
113
114
115
116
117
118
12
13
141
142
143
144
適用業務プロトコル
ホスト間プロトコル
ネットワーク・
アクセス・
プロトコル
セッション層
11
トランス・ポート
ネットワーク層
リンク層
14

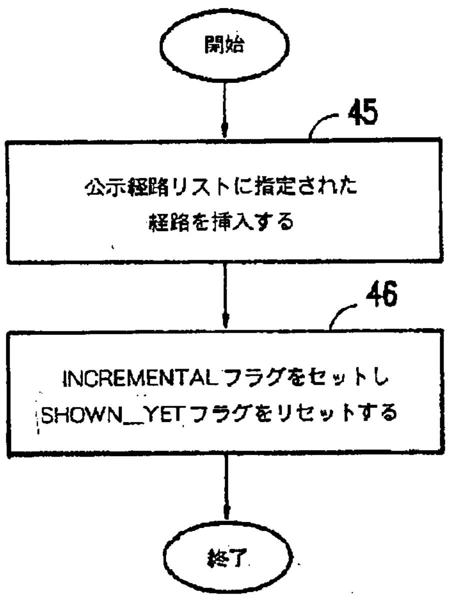
[Drawing 2]



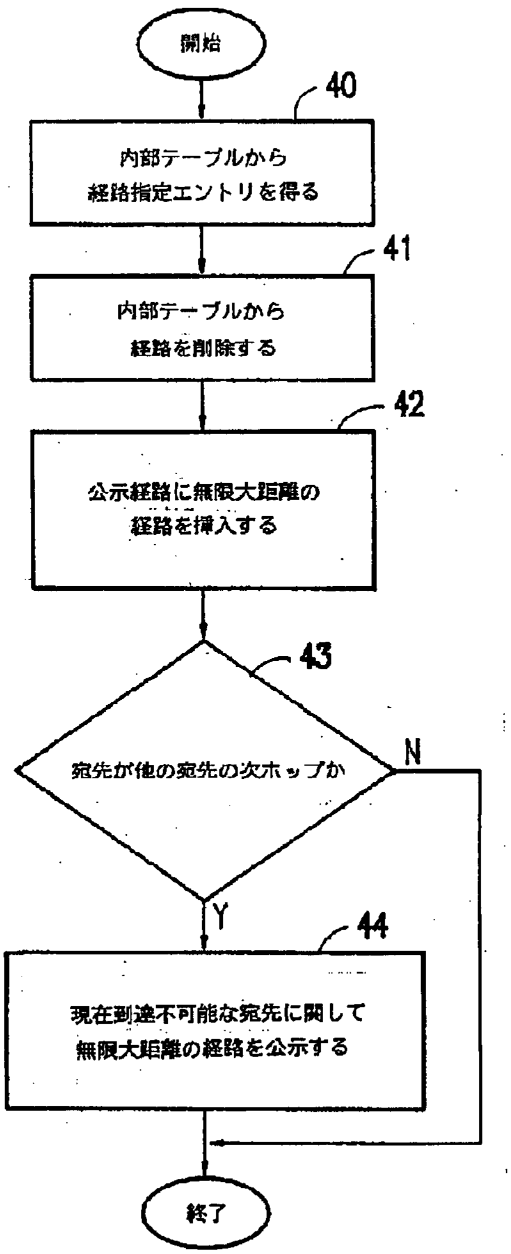
[Drawing 3]



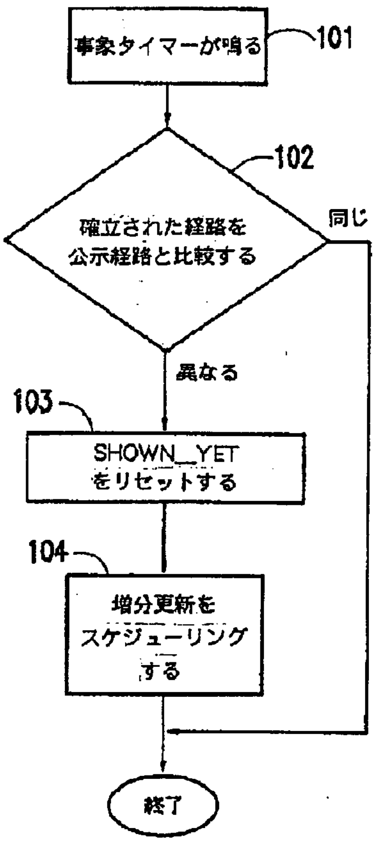
[Drawing 5]


開始
45
公示経路リストに指定された
経路を挿入する
46
INCREMENTAL フラグをセットし
SHOWN__YET フラグをリセットする
終了

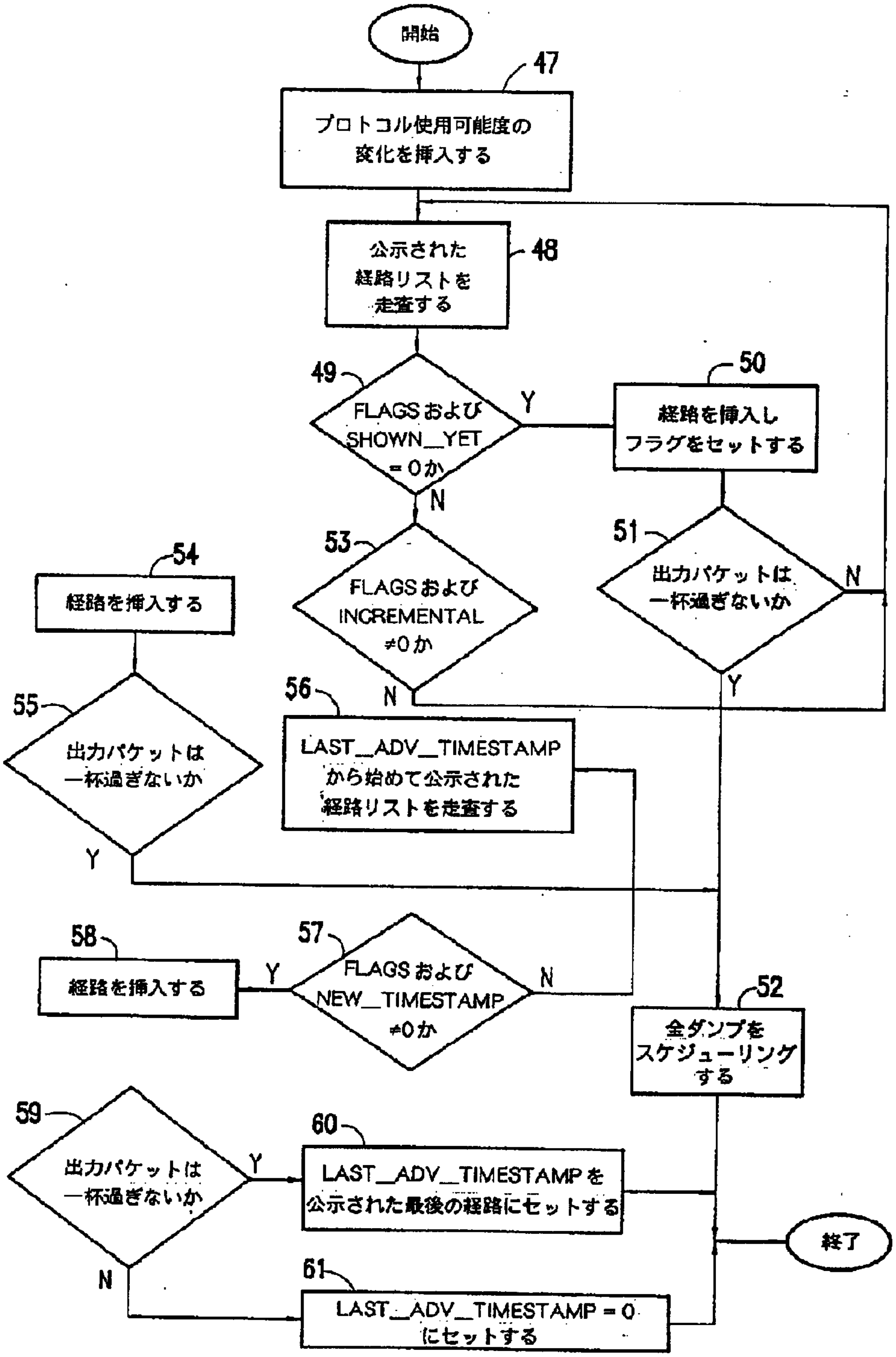
[Drawing 4]


開始
40
内部テーブルから
経路指定エントリを得る
41
内部テーブルから
経路を削除する
42
公示経路に無限大距離の
経路を挿入する
43
宛先が他の宛先の次ホップか
N
Y
44
現在到達不可能な宛先に関して
無限大距離の経路を公示する
終了

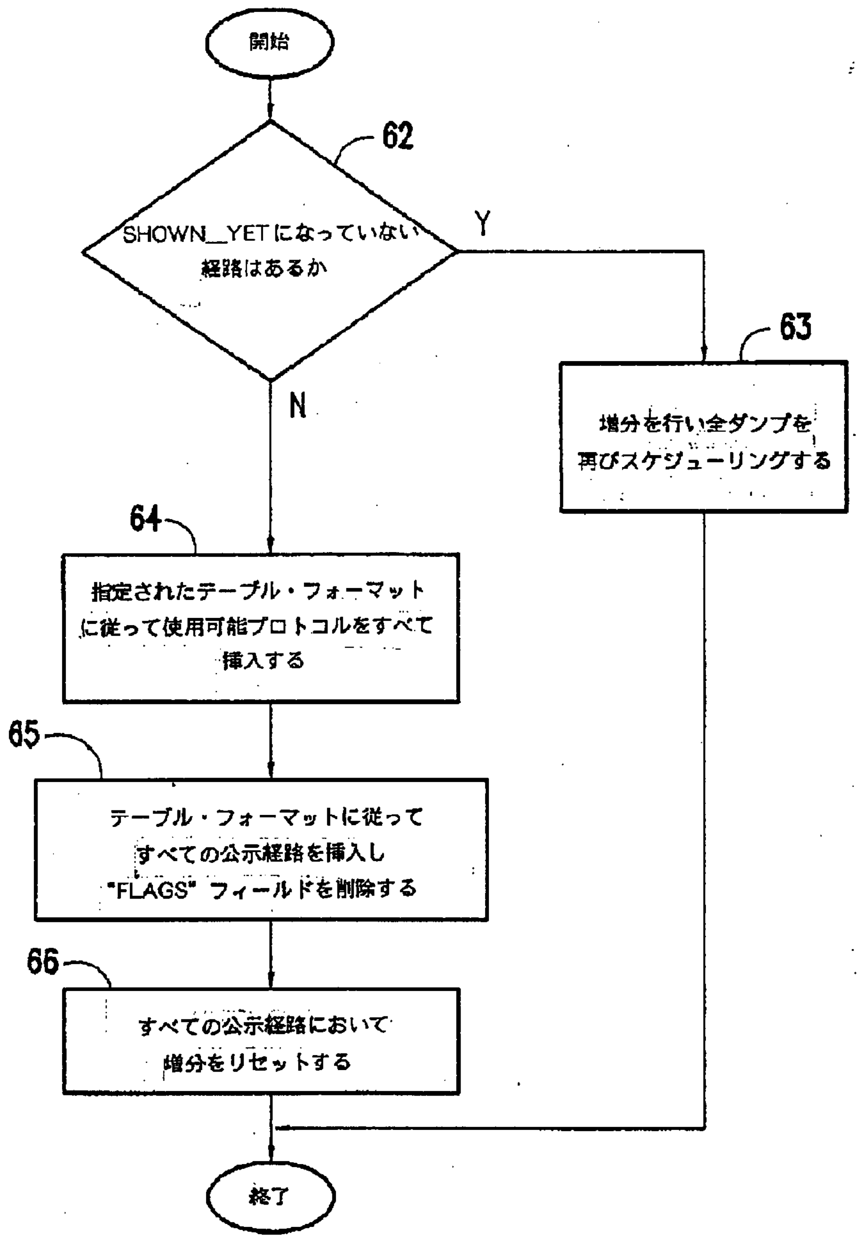
[Drawing 10]


事象タイマーが鳴る
101
102
確立された経路を
公示経路と比較する
同じ
異なる
103
SHOWN_YET
をリセットする
104
増分更新を
スケジューリング
する
終了

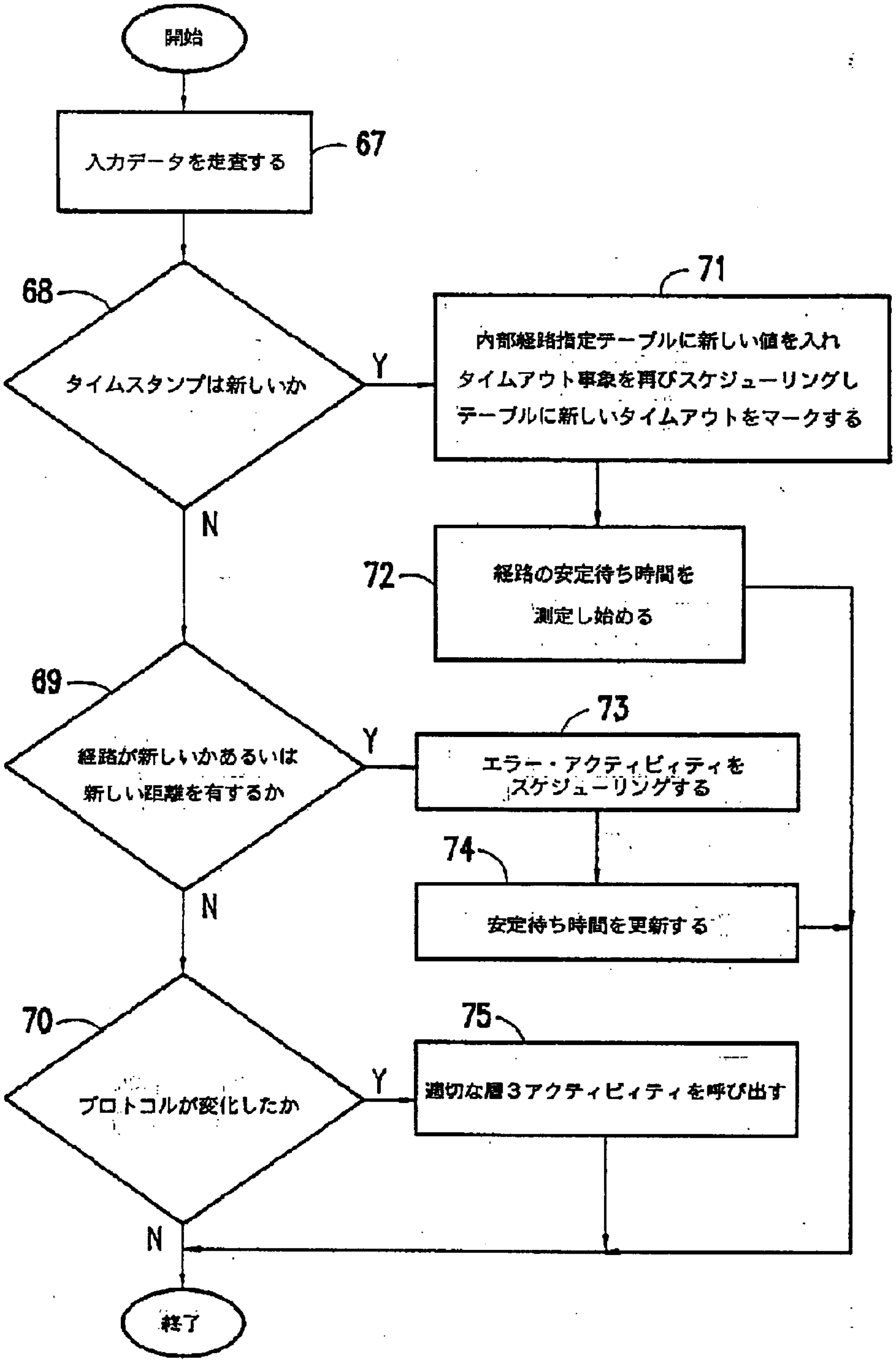
[Drawing 6]


開始
47
プロトコル使用可能度の
変化を挿入する
48
公示された
経路リストを
走査する
49
FLAGSおよび
SHOWN__YET
=0か
Y
N
50
経路を挿入し
フラグをセットする
51
出力パケットは
一杯過ぎないか
N
Y
53
FLAGSおよび
INCREMENTAL
≠0か
N
54
経路を挿入する
55
出力パケットは
一杯過ぎないか
Y
56
LAST__ADV__TIMESTAMP
から始めて公示された
経路リストを走査する
57
FLAGSおよび
NEW__TIMESTAMP
≠0か
Y
N
58
経路を挿入する
52
全ダンプを
スケジューリング
する
59
出力パケットは
一杯過ぎないか
Y
N
60
LAST__ADV__TIMESTAMPを
公示された最後の経路にセットする
終了
61
LAST__ADV__TIMESTAMP = 0
にセットする

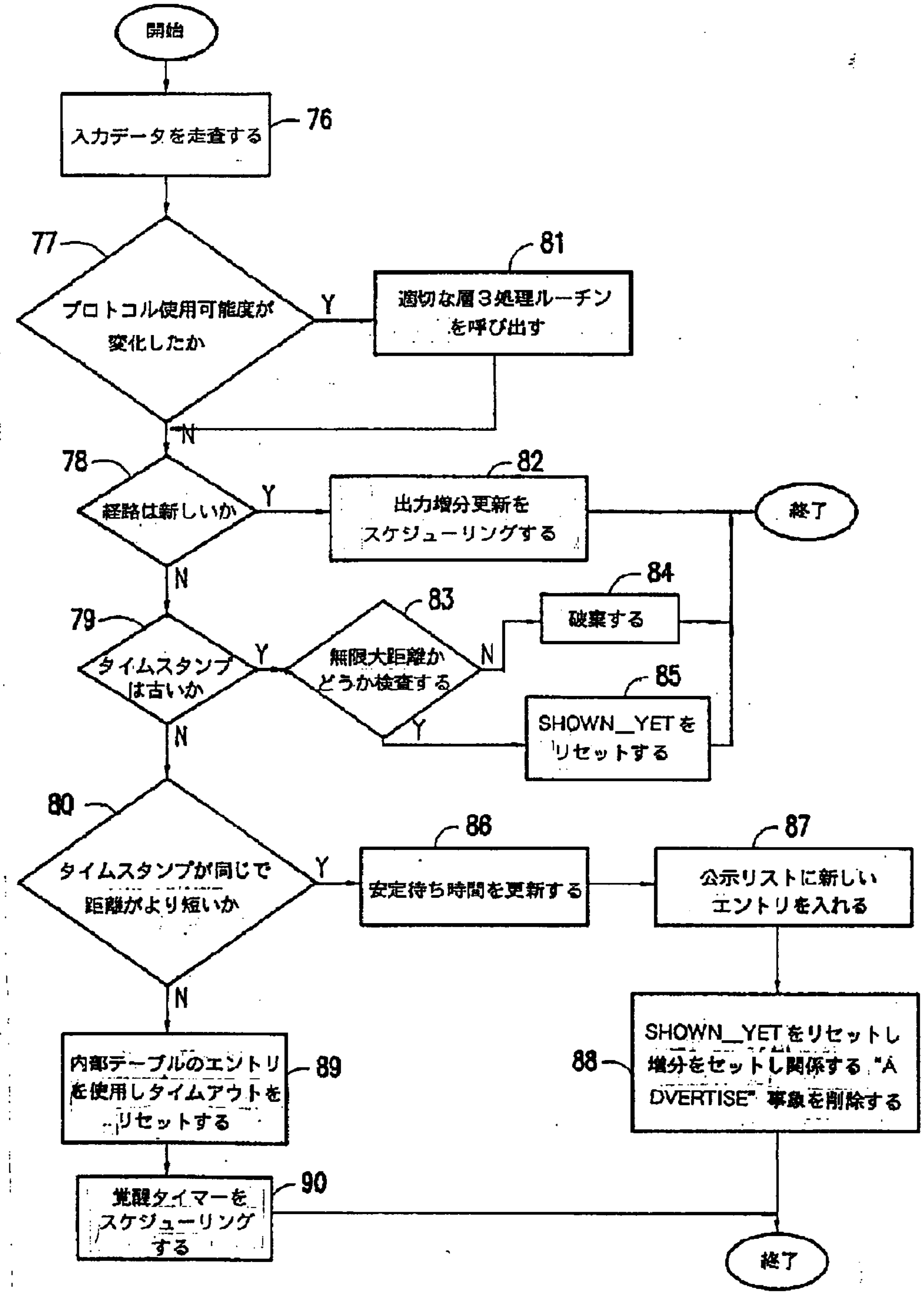
[Drawing 7]


開始
62
SHOWN__YETになっていない経路はあるか
Y
N
63
増分を行い全ダンプを再びスケジューリングする
64
指定されたテーブル・フォーマットに従って使用可能プロトコルをすべて挿入する
65
テーブル・フォーマットに従ってすべての公示経路を挿入し"FLAGS" フィールドを削除する
66
すべての公示経路において増分をリセットする
終了

[Drawing 8]


開始
入力データを走査する
67
68
タイムスタンプは新しいか
Y
71
内部経路指定テーブルに新しい値を入れ
タイムアウト事象を再びスケジューリングし
テーブルに新しいタイムアウトをマークする
N
72
経路の安定待ち時間を
測定し始める
69
経路が新しいかあるいは
新しい距離を有するか
Y
73
エラー・アクティビィティを
スケジューリングする
74
安定待ち時間を更新する
N
70
プロトコルが変化したか
Y
75
適切な層3アクティビィティを呼び出す
N
終了

[Drawing 9]



[Translation done.]

③

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12/56						
			H04L	11/00	310 B	
		9466－5K		11/20	102 D	

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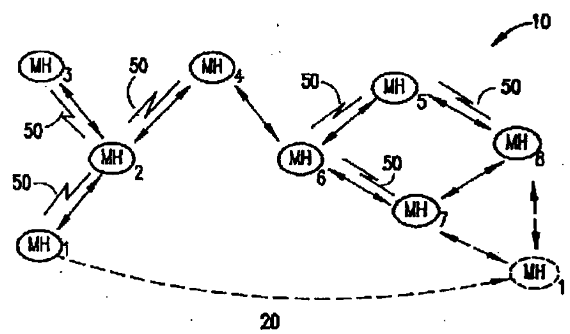
(54)【発明の名称】　経路指定方法

(57)【要約】

【目的】　ネットワークの各局で記憶された経路指定テーブルを使って、移動局のアドホック・ネットワークの局間でパケットを伝送する。

【構成】　要求に応じて新しい経路を示し、最近変化した経路を周期的に示し、それにより頻度は低いが全既知経路の完全ダンプを提供するという3つのスケジュールに従って、経路指定情報が同報通信またはマルチキャストされる。新しい経路により再同報通信が即座に開始され、その結果この情報が迅速に拡散される。経路は、周期的に公示される。この公示はほとんどの場合、主として、記憶されたすべてのものが、同報通信移動ホストに関してまだ正しいことをすべての隣接局に通知するために役立つ。振動を弱めるために、経路変化の頻度に関する情報が保持される。このデータに基づき、まもなく変化しようとする経路の公示を遅延するように決定が下され、これにより経路指定テーブルの振動を弱める。



【特許請求の範囲】

【請求項１】それぞれ固有ネットワーク・アドレスを持つが固定位置を持たない複数の移動ホストから構成されるアドホック・ネットワークに結合された２つの移動ホスト間で、パケットの情報を経路指定する方法であって、
各移動ホストにおいて、ソース移動ホストから宛先移動ホストまでのホップ数として定義された「距離」を含む経路指定テーブルを記憶する段階と、
各移動ホストに記憶された経路指定テーブルを、その移動ホストが周期的に同報通信することにより経路を公示する段階と、
宛先移動ホストから発したタイムスタンプで、各経路指定テーブルのエントリをタグ付けする段階と、
他の移動ホストから受け取った同報通信に基づいて、各宛先移動ホストごとに、移動ホストに記憶された経路指定テーブルを更新する段階と、
各移動ホストが、隣接移動ホストから受け取った新しい経路指定情報を再伝送する段階と、
所望の宛先移動ホストに関する最良の「距離」を有する経路として、ソース移動ホストからパケットの情報を伝送するための経路を選択する段階とを含む方法。

【請求項２】アドホック・ネットワークが、ネットワーク層とリンク層とを含むネットワーク規格に従い、経路指定がアドホック・ネットワークのリンク層で実行されることを特徴とする、請求項１に記載の経路指定方法。

【請求項３】新しい経路が、より短い距離または無限の距離を有する経路と定義され、無限の距離は、破壊されたリンクを表し、すなわち特定の宛先が到達可能でなくなり、したがってこの新規の到達不可能な宛先に依存する他のすべての宛先がそれ自体到達不可能になることを意味し、隣接移動ホストから受け取った新しい経路指定情報を再伝送する前記段階が、新しい経路指定情報の受信時に移動ホストによって即時実行されることを特徴とする、請求項１に記載の経路指定方法。

【請求項４】前記経路指定テーブルに記憶された経路が変化する頻度に関するデータを保持する段階と、
前記経路指定テーブルに記憶された経路の平均安定待ち時間を決定することによって、経路の安定性を測定する段階と、
測定された経路の安定待ち時間を安定待ち時間テーブルに、記憶する段階と、
公示段階の前に安定待ち時間テーブルにアクセスし、まもなく変化する可能性のある経路の公示を遅らせ、それにより前記経路指定テーブル内の情報の変動を少なくする段階とをさらに含む、請求項１に記載の経路指定方法。

【請求項５】古い測定値よりも大きな加重因子を有する特定の経路の安定待ち時間の最新の測定値をカウントすることにより、測定された経路安定待ち時間に重み付けを行う段階をさらに含む、請求項４に記載の経路指定方法。

【請求項６】アドホック・ネットワークがさらに、
移動ホストのネットワーク層アドレスに基づいて、前記経路指定テーブルに経路指定情報を記憶する段階と、
前記経路指定テーブルに記憶された経路が変化する頻度に関するデータを保持する段階と、
前記経路指定テーブルに記憶された経路の平均安定待ち時間を決定することにより、経路の安定性を測定する段階と、
測定された経路の安定待ち時間を安定待ち時間テーブルに記憶する段階と、
公示段階の前に安定待ち時間テーブルにアクセスし、まもなく変化する可能性のある経路の公示を遅らせ、それにより前記経路指定テーブル内の情報の変動を少なくする段階とをさらに含む、請求項１に記載の経路指定方法。

【請求項７】移動ホストのリンク層アドレスに基づいて、前記経路指定テーブルに経路指定情報を記憶する段階と、
前記経路指定テーブルに記憶された経路が変化する頻度に関するデータを保持する段階と、
前記経路指定テーブルに記憶された経路の平均安定待ち時間を決定することにより、経路の安定性を測定する段階と、
測定された経路の安定待ち時間を安定待ち時間テーブルに記憶する段階と、
公示段階の前に安定待ち時間テーブルにアクセスし、まもなく変化する可能性のある経路の公示を遅らせ、それにより前記経路指定テーブル内の情報の変動を少なくする段階とをさらに含む、請求項１に記載の経路指定方法。

【請求項８】ネットワーク層プロトコル使用可能度データを宛先ごとに追跡する段階をさらに含む、請求項１に記載の経路指定方法。

【請求項９】それぞれ固有ネットワーク・アドレスを持つが固定位置をもたない複数の移動ホストから構成され、ネットワーク層とリンク層とを含み、ネットワーク規格に従うアドホック・ネットワークに結合された２つの移動ホスト間で、パケットの情報を経路指定する方法であって、
各移動ホストにおいて、ソース移動ホストから宛先移動ホストまでのホップ数として定義された「距離」を含む経路指定テーブルを記憶する段階と、
各移動ホストに記憶された経路指定テーブルを、その移動ホストが周期的に同報通信することにより経路を公示する段階と、
宛先移動ホストから発したタイムスタンプで、各経路指定テーブルのエントリをタグ付けする段階と、
他の移動ホストから受け取った同報通信に基づき、移動

ホストに記憶された経路指定テーブルを移動ホストごとに更新する段階であって、前記更新が、より良い距離または無限の距離を有する経路と定義される新しい経路に限定され、無限の距離が破壊リンクを表し、すなわち、特定の宛先が到達可能でなくなり、したがってこの新規の到達不可能な宛先に依存する他のすべての宛先がそれ自体到達不可能になることを意味する更新段階と、
隣接移動ホストから受け取った新しい経路指定情報を各移動ホストが再伝送する段階であって、移動ホストが新しい経路指定情報を受け取ると即時に実行される再伝送段階と、
所望の宛先移動ホストに関する最短の「距離」を有する経路として、ソース移動ホストからパケットの情報を伝送する経路を選択する段階とを含む方法。
【請求項１０】前記経路指定テーブルに記憶された経路が変化する頻度に関するデータを保持する段階と、
前記経路指定テーブルに記憶された経路の平均安定待ち時間を決定することにより、経路の安定性を測定する段階と、
測定した経路の安定待ち時間を安定待ち時間テーブルに記憶する段階と、
公示段階の前に安定待ち時間テーブルにアクセスし、まもなく変化する可能性のある経路の公示を遅らせ、それにより前記経路指定テーブル内の情報の変動を少なくする段階とを含む、請求項９に記載の経路指定方法。
【請求項１１】古い事象よりも大きな加重因子を有する特定経路の安定待ち時間の最新の測定値をカウントすることによって、測定された経路安定待ち時間に重み付けを行う段階をさらに含む、請求項１０に記載の経路指定方法。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は、一般に無線データ通信システムに関し、より詳細には移動コンピュータ用のリンク層経路指定に関する。
【０００２】
【従来の技術】様々な多くのネットワーク・プロトコルが定義されている。たとえば、インターナショナル・ビジネス・マシーンズ（ＩＢＭ）コーポレイションは、ＩＢＭコンピュータおよびその互換コンピュータ用の通信を可能にする特定のプロトコルを定義するシステム・ネットワーク体系（ＳＮＡ）を確立した。国際標準化機構（ＩＳＯ）は、開放型システム間相互接続（ＯＳＩ）アーキテクチャ用の規格を発表した国際団体である。国防データ・ネットワーク（ＤＤＮ）規格は、ローカル・エリア・ネットワーク（ＬＡＮ）の相互接続を支援するインターネット・プロトコル（ＩＰ）用の基準を確立している。ＩＰは、ユーザに提供されるサービスを定義し、それらのサービスを支援するために必要な機構を指定している。この規格はまた、下位プロトコル層に必要なサービスを定義し、上位と下位のインターフェースを記述し、実施に必要な実行環境サービスの概要を記述している。
【０００３】伝送制御プロトコル（ＴＣＰ）は、パケット交換コンピュータＬＡＮおよびインターネットワークにおいて、接続本位の信頼性の高い端末間データ伝送を提供トランスポート・プロトコルである。ＩＰとＴＣＰは、ネットワークまたはサブネットワークの境界を横切って接続するかまたは接続性を利用する可能性を有する、米国防総省（ＤｏＤ）のすべてのパケット交換ネットワークを使用するために必須である。インターネットワーキングに使用されるそのようなネットワークにおいて、ホスト、フロント・エンド、ゲートウェイなどのネットワーク要素はＴＣＰ／ＩＰを実施しなければならない。
【０００４】ＩＰは、パケット交換通信ＬＡＮを相互接続してインターネットワークを構成するように設計されている。ＩＰは、インターネット・ダイアグラムと呼ばれるデータのブロックをインターネットを介してソースから宛先まで伝送する。ソースおよび宛先は、同じサブネットワーク上または接続されたＬＡＮ上のいずれかにあるホストである。ＤＤＮ規格は、ホストのＩＰを指定する。ＩＰは、ＤｏＤアーキテクチャ・モデルで定義されているので、インターネットワーク層に存在する。したがって、ＩＰは、トランスポート層のプロトコルにサービスを提供し、下位ネットワーク・プロトコルのサービスに依拠する。ＩＰの下位に様々なネットワーク・アクセス・プロトコルが存在し、それには、たとえばイーサネット・プロトコル、Ｘ．２５プロトコル、および本明細書において特に重要な無線媒体アクセス・プロトコルが含まれる。
【０００５】インターネット・プロトコルは本来、それぞれ固有のインターネット・アドレスを指定されたユーザが、固定した位置でネットワークに接続されるという仮定のもとで開発された。しかし、無線プロトコルを使用する携帯用またはハンドヘルドのコンピュータに関しては、一般に、ネットワークのあちこちにユーザが移動するのが、例外というよりもむしろ通例である。その結果として、このタイプの使い方がインターネット・プロトコルの設計の暗黙的前提に反するという点で問題が生じる。
【０００６】現在は、コンピュータ相互の位置に関して特別な前提を設けない限り、無線データ通信装置を有する移動コンピュータを、互いに接続を維持したままで自由に動き回れるようにする方法はない。ある移動コンピュータはしばしば、それら自体ではデータを直接に交換できない他の２台の移動コンピュータとデータを交換できることがある。その結果、会議室内のコンピュータ・ユーザは、特にユーザが室内をあちこち移動するとき、ネットワーク接続を維持するためにその仲間のどのコン

ピュータを頼りにすることができるか予測できないことがある。

【０００７】ホストに割り当てられたネットワーク層アドレスがネットワーク・トポロジに関して何の意味ももたないときに、最適ネットワーク層経路指定を移動ホストに提供することに関して問題が生じる。この問題が生じるのは、ホストが、ホストが移動する時でも固定したままの識別子を有し、同時にネットワーク層においてネットワーク層経路指定を実現可能にするのに十分な情報を提供する必要があるためである。

【０００８】

【発明が解決しようとする課題】したがって、本発明の目的は、変化する任意の相互接続経路に沿って任意の時点でデータを交換できる移動コンピュータ群が、そのすべてのコンピュータに、データを交換できる（できれば複数ホップの）経路を与えることができる、データ通信システムを提供することである。

【０００９】さらに、本発明のより具体的な目的は、固定基地局の助けなしでリンク層経路指定を使用することによって、常に変化する経路に沿って複数の移動コンピュータ間でデータが交換できる技法を提供することである。

【００１０】

【課題を解決するための手段】本発明によれば、無線データ通信ネットワークの局間でパケットを経路指定するための方法および装置が提供される。ネットワークの各局に記憶された経路指定テーブルを使って、パケットがネットワークの局間で伝送される。各局で記憶された各経路指定テーブルは、その局からアクセス可能な各局のリストと、アクセス可能な各局に達するために必要なホップ数とを提供する。これらのテーブルを動的に変化するトポロジにおいて維持するために、リンク層パケットを各局から伝送してテーブルを更新する。これらのリンク層パケットは、各局からアクセス可能な局とこのアクセス可能な局に達するために必要なホップ数とを示す。

【００１１】経路指定情報は、伝送されるリンク層パケットを、ネットワーク内での局の移動の結果検出されるトポロジの変化として周期的かつ増分的に同報通信またはマルチキャストすることによって公示される。また、変動を弱めるために、経路が変化する頻度に関する情報を保持する。このデータに基づいて、まもなく変化する経路の公示を遅らせそれによって経路指定テーブルの変動を弱める決定を下すことができる。干渉する２つのリンク層パケット間の変動を防ぐために、ある経路の公示が遅延される。

【００１２】

【実施例】ここで図面、特に図１を参照すると、ネットワークのプロトコル層を例示する国防データ・ネットワーク（ＤＤＮ）のアーキテクチャ図が示されている。最上層１１は、様々な適用業務プロトコル１１１および適用業務プログラム１１２と１１３を含むセッション層である。それに加えて通常、電子メール（ｅメール）適用業務プログラム１１４がある。これらは、適用業務固有のプロトコルによって、トランスポート層すなわち層４と通信する。たとえば、適用業務プロトコル１１１はその固有モード１１５を介して層４と通信し、適用業務プロトコル１１２はファイル転送プロトコル（ＦＴＰ）１１６によって通信し、適用業務プログラムはテルネット・プロトコル１１７によって通信し、メール適用業務１１４は単純メール転送プロトコル（ＳＭＴＰ）１１８によって通信する。

【００１３】層４すなわちトランスポート層は伝送制御プロトコル（ＴＣＰ）トランスポート層１２から構成してもよく、層３すなわちネットワーク層はインターネット・プロトコル（ＩＰ）層１３から構成される。２つの層１２と１３は、共通の名前とアドレス空間を共用する一組のＴＣＰ／ＩＰプロトコルを含む。

【００１４】リンク層１４すなわち層２は、リンク層と媒体アクセス制御（ＭＡＣ）層から構成される。リンク層１４には、イーサネット１４１、ＤＤＮ規格Ｘ．25 142、無線プロトコル１４３、およびトークンリング１４４を含む様々なネットワーク・アクセス・プロトコルが含まれる。これらは一般に、規格団体によって公表された規格によって定義されている。たとえば、イーサネットはＩＥＥＥ（米国電気電子学会）規格８０２．３によって定義され、トークン・リングはＩＥＥＥ規格８０２．５によって定義される。

【００１５】最後に、層１（図示せず）は物理層である。この層は、データ符号化を含む配線、接続および伝送パラメータに関係する。インターネットワーキングの層およびプロトコルの詳細な情報は、Ｅ．コマー（Comer）著"Internetworking with TCP/IP,Volume I:Principles,Protocols,and Architecture"、Prentice-Hall(1990)を参照されたい。

【００１６】従来の経路指定技法に従って、層３に同様の技法を使用してもよいが、本発明の好ましい実施例の実施は、図１に示したアーキテクチャのリンク層または層２として識別された部分を特に対象とする。本発明によれば、各移動局は、その現隣接局のそれぞれに、それ自体の隣接局のリストを公示する必要がある。このリスト内のエントリは経時的に動的にかなり変化し、したがって、すべての移動コンピュータが常にその群の他のすべての移動コンピュータを確実に探し出せるように十分頻繁に公示を行わなければならない。さらに、各移動コンピュータは、要求に応じて、データを別のコンピュータに中継することに同意する。このように、移動コンピュータは、データの目標が直接通信の範囲内でない場合でも、グループ内の他の移動コンピュータとデータを交換することができる。他のコンピュータを中間点として使用してデータを送るこの方法は、経路指定として知ら

れる。経路指定はこれまで、ネットワーク・プロトコルのリンク層では移動コンピュータ・システムに関する上記の問題には適用されていなかった。群中の特定のコンピュータから他のどの移動コンピュータがアクセス可能であるかという通知は、本発明によればプロトコルのリンク層で行われ、したがって上位層（たとえばネットワーク層）のプロトコルが使用中であっても本発明の方法は動作する。集合内の移動コンピュータ群は、事実上新しい「ネットワーク」を構成し、管理なしでそうする。この通信の形式は、「アドホック（ａｄ－ｈｏｃ）」ネットワーキングと呼ばれている。

【００１７】移動コンピュータはしばしば、建物内の有線バックボーンに沿ってネットワーク接続を維持する他のコンピュータとデータを交換することを可能にする「基地局」と一緒に使用される。この場合、基地局は常に多量の電力を有すると想定され、それに対して移動コンピュータは電力供給が厳しく制限されていることがあるので、経路指定機能は主に基地局が引き受ける。基地局は、移動コンピュータが基地局の範囲内のあらゆる移動コンピュータにアクセスを持つことを各基地局に任せるような形でリンク層経路指定に関与する。移動コンピュータが基地局の範囲内にある場合は、その隣接局リストの周期的な同報通信によって、基地局に直接接続性を公示する。基地局は、異なるセルの移動コンピュータ間でデータ交換経路を作成するためにどの移動局が協力できるかというリストを同報通信することもしないこともある。

【００１８】上記の経路指定機能はすべてリンク層アドレス指定技法（いわゆる「ハードウェア・アドレス指定」）を使用するので、上記の方法は単一の物理媒体を使用する導入設備にほとんど適用できる。異なるネットワークにあるコンピュータが、ネットワーク層技法を使用してデータ交換用の経路を確立し維持する。本明細書に記載するリンク層経路指定の方法は、そのような他の技法と一緒に使用することができ、あるいは層２（すなわち「ハードウェア」）のアドレスの代わりに層３のアドレスを考慮し、層３のプロトコル・リストの伝送を無視することによって、層３で使用するためにのみ適合させることもできる。リンク層で単一のネットワーク・データ経路を提示することができ、ネットワーク層で複数のネットワーク・データ経路を処理することができる。複数ネットワーク設備における基地局は、必要なデータ経路をリンク層とネットワーク層のどちらで確立するかを決定する責任がある。基地局を含まないときは、本明細書で述べるリンク層経路指定をもっぱら移動コンピュータが使用する。

【００１９】それら自体の間でデータ経路を作成するために相互動作するコンピュータはすべて、周期的に、たとえば１秒に１回または数秒に１回（あるいは、結局、新たな同報通信が必要なことを確実に決定できる方法が設計されているときは、必要とされるだけ）必要データを同報通信する。各移動コンピュータによるデータ同報通信は、各宛先について、少なくとも以下の情報を有する経路指定テーブルを含む。

・宛先のリンク層アドレス。
・宛先に達するのに必要なホップ（ｈｏｐ）数。
・元々宛先によってスタンプされた、その宛先に関して受け取った情報のタイムスタンプ。
・宛先が省略時ルータとして働くことを望むかどうか（たとえば、宛先が基地局である）。

また伝送された経路指定テーブルは、リンク層ソフトウェアの当然の動作によって、それらを伝送する移動コンピュータのハードウェア・アドレスを含む。経路指定テーブルはまた、送信側によって作成されたタイムスタンプも含む。さらに、特定の移動コンピュータが同一セル内でアクセス可能か否かを決定しようとする経路指定アルゴリズムでは、どの基地局が各移動コンピュータにサービスしているかを示す表示を含んでもよい。

【００２０】そのような経路指定テーブルを移動コンピュータが受け取ると、そのコンピュータは、ローカルに記憶されたそれ自体の経路指定テーブルを更新し始める。各受信経路は、同じ宛先と次ホップを示す全ての既存の経路を更新する。タイムスタンプは新しいタイムスタンプで置き換えられ、各受信経路中に示されたホップ数は増分され記憶される。任意のコンピュータまでの経路に沿ったホップ数は、その経路に関する「距離（ｍｅｔｒｉｃ）」と呼ばれる。経路指定テーブルの送信側のアドレスは、宛先までの進路に沿った次ホップのアドレスとして記憶される。（最後の）宛先までの経路に沿ったさらに他のアドレスは記憶する必要がない。既存のいずれの（宛先、次ホップ）アドレス対にも対応しない経路エントリを受け取ったときは、新しいエントリがその宛先に割り振られる。伝送される経路指定テーブルを発したコンピュータに関してローカル経路指定テーブルのエントリが作成または更新され、そのエントリに関する距離は１になり、コンピュータに達するためにただ１回のホップを必要とすることを示す。言い換えると、この２つのコンピュータ（経路指定テーブルの送信側と受信側）は「隣接局」である。

【００２１】各宛先は、その代替経路指定経路に沿った次ホップに関して、異なるリンク層アドレスでそれぞれ指定された、限られた（少ない）数の代替経路を有する。転送決定を行うための基準として、常により新しいタイムスタンプを有する経路が選ばれるが、必ずしも公示（advertise）する必要はない。他にも代替経路が可能であるようなときは、最短距離を有する経路が記憶され、その他の経路は忘れられる。同じ距離の代替経路間で選択を行わなければならない場合は、最新のタイムスタンプを有する経路が選択される。ローカル経路指定テーブルを伝送する各移動コンピュータは、各伝送をその

ローカル時間値でスタンプするので、ほとんどすべてのタイムスタンプは最終宛先から発する。経路指定テーブルが伝播される自然な方法によって、他の各コンピュータにタイムスタンプが選ばれ、それらの他のコンピュータは、起点となる移動コンピュータに関する経路指定エントリを維持することを決定することができる。移動コンピュータが同期している場合は、移動コンピュータのアドホック共同体全体に対してタイムスタンプが１つだけ必要である。

【００２２】以上述べたことは、事実上、必要な経路指定データを伝播し記憶する方法についてだけであった。経路指定テーブルをローカルに操作し更新する実際の方法の詳細は後で述べる。データは、入力パケット用と出力パケット用の２つの方法で使用される。リンク層経路指定の動作は、リンク層と、もしある場合にはネットワーク層プロトコル（国際標準化機構（ＩＳＯ）の成層ネットワーク用語における「層３」）との間に挿入される薄いプロトコル層で行われるものと考えると最もよく理解される。すなわちリンク層経路指定は、出力パケットについては、他のリンク層動作の前、任意の高水準プロトコル動作の後に行われる。反対に入力パケットについては、本明細書のリンク層経路指定動作は、他のリンク層動作（たとえば、フレーム指示、データ保全性の検査）の後、他の高水準プロトコル動作の前に実行される。

【００２３】出力パケットについては、リンク層経路指定動作は実際の宛先が隣接するコンピュータか否かを判定し、そうでない場合は、リンク層が受け取ったデータはカプセル化され、新しい宛先アドレスと新しい層２（リンク層）のパケット・タイプを含む新しいリンク層ヘッダが構築される。新しい宛先は、実際の宛先までの進路に沿った次ホップの宛先である。パケット・タイプは、ここに記載するリンク層経路指定手順を開始するための一般に合意された数である。すなわち、アドレス分解プロトコル（ＡＲＰ）が要求しあるいは高水準プロトコル処理が開始されるのと同じ方式で、新しい経路指定要求の様々な処理が開始される。リンク層経路指定モジュールが受け取ったデータが新しいパケット・タイプと新しい宛先で包まれようがそうでなかろうが、パケットはリンク層の通常動作によって伝送される。

【００２４】そのようなリンク層動作によって別の宛先に経路指定される必要があるパケットが入ってくると、そのパケットは次ホップに再アドレス指定されて送られる。次ホップが実際の宛先である場合は、経路指定のために必要な元のデータをカプセルから取り出しカプセルを廃棄することによって、実際の宛先と実際に必要なパケット・タイプが露出される。次ホップが実際の宛先ではない場合は、パケット・タイプとリンク層ヘッダは、見かけ上の宛先がその進路に沿った次ホップのアドレスに変更される以外はそのままになり、チェックサムまたはデータ保全性標識が必要に応じて更新される。いずれの場合にも、リンク層経路指定を実行するコンピュータにおいて、リンク層より上のプロトコルは活動化されない。

【００２５】図２は、両方向無線リンク５０および移動ホストＭＨ１ないしＭＨ８を有するアドホック・ネットワーク１０を示す。また、点線で示すようにＭＨ２の隣の位置からＭＨ７とＭＨ８の隣の位置に移動するＭＨ１が示されている。本発明によって、固定した有線ネットワークの基地局との通信なしに、ネットワーク１０の移動ホスト間でパケットを経路指定することができる。ネットワーク１０を介してパケットを経路指定するために必要な情報は、各移動ホストで維持される表（後に示す）に含まれる。これらの表は、移動ホストの移動によって引き起こされるネットワーク１０の絶えず変化するトポロジを反映するように更新される。

【００２６】この概念の総体は、各移動ホストにその経路指定テーブルを周期的に同報通信させ、それに対応して隣接局からそのような同報通信を受け取ったとき、その経路指定テーブルを更新することである。このようにして、各同報通信が処理されるとき、すべての移動ホストは、アドホック・ネットワークを確立することを望む協力するすべての移動ホスト間の相互接続の現トポロジの完全な記述を構築する。各経路指定テーブルのエントリはタイムスタンプでタグ付けされ、そのタイムスタンプはベルマン・フォード経路指定などの宛先ベクトル・アルゴリズムに付随するいくつかの問題を解決するために使われる。そのようなアルゴリズムは、計算上効率的である。経路は、所望の宛先に対して「最良の」距離をもつとき選ばれる。「距離」は通常、宛先に到達する前にパケットが飛び越さなくてはならない「ホップ」の数である。

【００２７】同報通信において受け取った経路はまた、次にその経路指定情報を同報通信するときに受信側によって公示されるが、入力パケットが宛先に達するためにもう一回ホップ（すなわち、送信側から受信側までのホップ）を必要とするため、受信側は経路を公示する前に距離に増分を加える。

【００２８】選択すべき最も重要なパラメータの１つは、経路指定情報パケットを同報通信する合間の時間である。しかし、移動ホストが新しい経路情報または実質上修正された経路情報を受け取ると、新しい情報がすぐに再伝送され、協力するすべての移動ホストの間で最も迅速な経路指定情報の流布を達成する。この即時の再同報通信は、プロトコルができるだけ早く収れんしなければならないという新しい要件を導入する。移動ホストの移動によって、同報通信のあらしが起こり、無線媒体の使用可能性が低下すると悲惨なことになる。

【００２９】移動ホストは、所々に移動するとき破壊リンクを生じる。破壊リンクは「無限大」（すなわち、最

大許容距離よりも大きな任意の値）の距離で表される。次ホップまでのリンクが破壊されたとき、その次ホップを通るすべての経路に即座に無限大の距離が割り当てられ、更新されたタイムスタンプが割り当てられる。これは実質的な経路変化とみなされるため、同報通信の経路指定情報パケットにおいてそのような修正経路が即座に開示される。破壊リンクを記述するための情報の構築は、宛先移動ホスト以外の任意の移動ホストによってタイムスタンプが作成される唯一の状況である。また、移動コンピュータが同期されている場合は、１つのタイムスタンプだけが必要である。発生源である移動ホストによって定義されるタイムスタンプは偶数になるように定義され、無限大の距離を示すために作成されるタイムスタンプは奇数である。このようにして、任意の「実数」のタイムスタンプが、無限大の距離に取って代わる。

【００３０】極めて大きい移動ホスト群においては、経路指定情報パケットの同報通信の合間の時間におそらく調整が行われる。これらのパケットで運ばれる情報の量を減らすために、２つのタイプを定義する。一方は、「全ダンプ」と呼ばれ、使用可能なすべての経路指定情報を運ぶ。他方のタイプは、「増分式」と呼ばれ、最後の全ダンプ以降に変化した情報だけを運ぶ。増分式経路指定更新は、設計により、１つのネットワーク・プロトコル・データ単位（ＮＰＤＵ）に収まるようになっている。比較的小さな移動ホスト群の場合でも、全ダンプにはおそらく複数のＮＰＤＵが必要となる。移動ホストの移動が起こらないときは、比較的まれに、全ダンプを伝送することができる。移動が頻繁になり、増分の大きさがＮＰＤＵの大きさに近づくと、（次の増分が少なくなるように）全ダンプをスケジューリングすることができる。

【００３１】移動ホストが新しい経路指定情報を（通常は、前述の増分式パケットで）受け取ると、その情報を、前の経路指定情報パケットからあらかじめ入手可能な情報と比較する。より新しいタイムスタンプを有する経路が使用される。古いタイムスタンプを有する経路は破棄される。既存の経路と同じタイムスタンプを有する経路が「より良い」距離を有する場合は、その経路が選ばれ、既存経路は破棄され、または余り好ましくないものとして記憶される。新たに受け取った同報通信情報から選ばれた経路の距離は、それぞれ１ホップだけ増分される。新たに記録された経路、または改善された距離を示す経路は、現移動ホストの隣接局に即座に公示するようにスケジューリングされる。

【００３２】様々な移動ホスト間のタイミング・スキューが予期される。移動ホストによる経路指定情報の同報通信の合間の期間は、ある程度の規則正しさが予期される場合でも、多少非同期な事象とみなされる。そのように独立して伝送するエージェント群では、経路を更新するために上記手順を使うことによって、若干の変動が発生することがある。宛先移動ホストが移動しなかったときでも、ある次ホップから別の次ホップまでの経路を一貫して変化させるパターンで、特定の移動ホストが新しい経路指定情報を受け取るという問題が生じることがある。これは、選ぶべき新しい経路に関して、２つの進路すなわち遅いタイムスタンプを有するものとより良い距離を有するものがあるからである。移動ホストは常に、より新しいタイムスタンプとを有する、同じ宛先までの２つの経路を（異なる隣接局を介して）次から次へと受け取ると想像されるが、常に最初は悪い距離の経路を得る。注意しないと、これは、その宛先からの新しいタイムスタンプごとに、新しい経路伝送の連続バーストを引き起こす。新しい距離はそれぞれ、近くにあるすべての移動ホストに伝播され、さらにその隣接局がその隣接局に伝播し、以下同様に続く。

【００３３】本発明の好ましい実施例による解決法は、より良い距離を有する経路がまもなく現れそうだと移動ホストが判定できるときに、そのような経路の公示を遅延することである。遅いタイムスタンプを有する経路が使用可能でなければならないが、前に到達できなかった宛先への経路でない限り、即座に公示する必要はない。したがって、各移動ホストで保持される経路指定テーブルは２つあり、１方は転送パケットと共に使用するためのものであり、他方は増分式（および全）経路指定情報パケットを介して公示されるものである。より良い距離を示す経路指定情報の到着が近い確率を判定するために、移動ホストは、より良い距離によって更新される前に、一般に特定の経路が継続する長さの履歴を保持しなければならない。

【００３４】上記手順はすべて、プロトコル・スタックのネットワーク層（層３）とリンク層（層２）のどちらで実行されようとも有効である。したがって、層３のいくつかの可能なプロコトルを使って通信できる移動ホストのアドホック・ネットワークを設けたい場合、パケット同報通信と転送を層２で実施することができる。これにより、たとえば、中間移動ホストと同じ層３のプロコトルを実施しなかった２つの端点のサービスにおいて、中間移動ホストがパケットを転送できるようになる。

【００３５】経路指定テーブルに記憶されたアドレスは、このアドホック・ネットワーク・プロトコルが実施される層に対応する。つまり、層３における動作は次ホップ用のネットワーク層アドレスおよび宛先アドレスを使用し、層２における動作は層２の媒体アクセス制御（ＭＡＣ）アドレスを使用する。

【００３６】しかし、転送テーブルのためにＭＡＣアドレスを使用すると新しい要件が導入される。困ったことに、層３ネットワーク・プロトコルはネットワークの３つのアドレスに基づいて通信を実現するが、これらの層３アドレスをＭＡＣアドレスに分解する方法を提供しなければならない。そうでなければ、多数の異なるアドレ

ス分解機構が設けられ、その分解機構を利用するときは常に、無線媒体において対応する帯域幅の損失が認められることになる。このことは重要であり、その理由は、そのような機構はアドホック・ネットワークのすべての移動ホストによる同報通信と再伝送同報通信を必要とすることになるからである。したがって特別な注意を払わないと、アドレス解決はすべて、ネットワークの標準動作における不調のように見え、それはどの活動ユーザにもはっきりとわかるであろう。

【００３７】本発明による解決法は、層２における動作に関して、層２の経路指定情報に加えて層３プロトコル情報を含めることである。各宛先ホストは、層３のどのプロトコルを支援するかを公示し、宛先への到達可能性＊を公示する各移動ホストは、その公示の他に、宛先で支援される層３プロトコルに関する情報を含むことになる。この情報は、変化したときにだけ伝送すればよく、それはめったに起こらない。この情報は、各「全ダンプ」の一部として伝送されることになる。各移動ホストは、いくつか（あるいは多数の）の層３プロトコルを支援し得るので、このリストは長さが可変でなければならないことになる。

【００３８】表１に、図２に示したネットワーク１０内の各移動ホストで維持される内部転送テーブルにおける経路エントリの構造を示す。

【００３９】

【表１】

宛先アドレス	プロトコル依存サイズ
次ホップ・アドレス	プロトコル依存サイズ
距離	符号なしの整数
タイムスタンプ	宛先から；符号なしの整数
導入時間	装置依存（たとえば、３２ビット）
安定度データへのポインタ	装置依存
プロトコル・データへのポインタ	装置依存、層２のみ

【００４０】たとえば、図１における移動ホスト４を検討する。各移動ホストのアドレスをＭＨＸで表し、すべての移動ホストがインターネット・プロトコル（ＩＰ）だけで支援されると仮定する。さらにすべてのタイムスタンプがＴＮＮＮ＿ＭＨＸで示されると仮定する。このＭＨＸはタイムスタンプを作成したコンピュータを指定し、ＴＮＮＮは時間の値である。また、移動ホスト１が移動ホスト２から移動する前に、他のすべての移動ホス※トにタイムスタンプＴＮＮＮ　ＭＨＸを有するエントリがあると仮定する。このとき、ＭＨ４における内部転送テーブルは次のようになる（行は様々な移動ホストに対応し、列は前記構造で記述されたデータに対応することに留意されたい）。

【００４１】

【表２】

宛先	次ホップ	距離	タイムスタンプ	導入	フラグ	安定データ	プロトコル・データ
MH1	MH2	2	T406_MH1	T001_MH4		PTR1_MH1	PTR2_MH1
MH2	MH2	1	T128_MH2	T001_MH4		PTR1_MH2	PTR2_MH2
MH3	MH2	2	T564_MH3	T001_MH4		PTR1_MH3	PTR2_MH3
MH4	MH4	0	T710_MH4	T001_MH4		PTR1_MH4	PTR2_MH4
MH5	MH6	2	T392_MH5	T002_MH4		PTR1_MH5	PTR2_MH5
MH6	MH6	1	T076_MH6	T001_MH4		PTR1_MH6	PTR2_MH6
MH7	MH6	2	T128_MH7	T002_MH4		PTR1_MH7	PTR2_MH7
MH8	MH6	3	T050_MH8	T002_MH4		PTR1_MH8	PTR2_MH8

【００４２】これから、たとえば、ほとんどのコンピュータの導入時間がほぼ同じなので、すべてのコンピュータがほぼ同じ時間にＭＨ４にとって使用可能になったと推定される。また、すべてのタイムスタンプ・フィールドが単位桁が偶数の時間を有するので、コンピュータ間のリンクは１つも破壊されなかったと推定される。図１には、他の経路で置き換えられそうなまたは競合しそうな特定宛先への経路がないので、ＰＴＲ１　ＭＨＸはすべてヌル構造へのポインタとなる。プロトコル・データ・ポインタはすべて、以下のフォーマットを有する構造★を指す。プロトコルＩＤ＝ＩＰ、プロトコル・アドレス長＝４バイト、プロトコル・アドレス＝［ＭＨＸ．Net.addr.ess］

ここで、ＭＨ１．Net.addr.essは、標準のＩｎｔｅｒｎｅt4オクテット形式で表示されたＭＨ１に関する４バイトのＩＰアドレスである。

【００４３】表３は、公示された経路テーブルにおける経路エントリの構造を示す。

【００４４】

【表３】

宛先アドレス	プロトコル依存サイズ
距離	符号なしの整数
タイムスタンプ	宛先から；符号なしの整数

次の層3アドレスのサイズ　　8ビット、0のときはもうない
次アドレスのプロトコルID　　8ビット
次の層3プロトコルのアドレス

【0045】最後の項目は、層2でアドホック・アルゴリズムが動作するときにだけ現れる。次ホップはすべての公示に暗示されるので、リストする必要はない。動作が層2で行われ、移動ホストはアドレスX：X：X：X：X：Xを有し、したがって移動ホストはMACアドレス1：1：1：1：1：1（標準フォーマットで示した）を有すると仮定する。さらにIPは、層3のプロト＊コルID7を有するものとして示されると仮定する。またそれと対応して、移動ホストMHXのインターネット・アドレスは、X．X．X．X．と表されると仮定する。そこで、上記の状況において、公示される経路は以下のように表される。

【0046】

【表4】

宛先	距離	タイムスタンプ	長さ	ID	層3アドレス	長さ
1:1:1:1:1:1	2	T406_MH1	4	7	1.1.1.1	0
2:2:2:2:2:2	1	T128_MH2	4	7	2.2.2.2	0
3:3:3:3:3:3	2	T564_MH3	4	7	3.3.3.3	0
4:4:4:4:4:4	0	T710_MH4	4	7	4.4.4.4	0
5:5:5:5:5:5	2	T392_MH5	4	7	5.5.5.5	0
6:6:6:6:6:6	1	T076_MH6	4	7	6.6.6.6	0
7:7:7:7:7:7	2	T128_MH7	4	7	7.7.7.7	0
8:8:8:8:8:8	3	T050_MH8	4	7	8.8.8.8	0

【0047】ここで、移動ホスト1が移動ホスト5および7の周辺に移動し、他の移動ホスト（特に移動ホスト2）から離れたと仮定する。移動ホスト4における新し※い内部転送テーブルは以下のようになる。

【0048】

【表5】

宛先	次ホップ	距離	タイムスタンプ	導入	フラグ	安定データ	プロトコル・データ
MH1	MH6	3	T516_MH1	T810_MH4	M	PTR1_MH1	PTR2_MH1
MH2	MH2	1	T238_MH2	T001_MH4		PTR1_MH2	PTR2_MH2
MH3	MH2	2	T674_MH3	T001_MH4		PTR1_MH3	PTR2_MH3
MH4	MH4	0	T820_MH4	T001_MH4		PTR1_MH4	PTR2_MH4
MH5	MH6	2	T502_MH5	T002_MH4		PTR1_MH5	PTR2_MH5
MH6	MH6	1	T186_MH6	T001_MH4		PTR1_MH6	PTR2_MH6
MH7	MH6	2	T238_MH7	T002_MH4		PTR1_MH7	PTR2_MH7
MH8	MH6	3	T160_MH8	T002_MH4		PTR1_MH8	PTR2_MH8

【0049】MH1のエントリだけが新しい距離を示しているが、間の時間には、多くの新しいタイムスタンプ・エントリを受け取っている。すなわち、最初のエントリは、フラッグM（距離MetricのM）を有し、次の全ダンプが生じるまでに、続いて起こる増分経路指定情報の更新において公示されなければならない。移動ホスト1が移動ホスト5と7の周辺に移動したとき、増分式経路指定情報の即時更新を開始した。これはその後、移動ホスト6に同報通信された。また、移動ホスト6は、重要で新しい経路指定情報を受け取ったと判断し、移動ホスト1に関する新しい経路指定情報を移動ホスト4に運ぶ即時更新を開始した。移動ホスト4は、この情報を受け取ると、次の経路指定情報の全ダンプまで、それをすべての間隔で同報通信することになる。移動ホスト4において、増分式公示経路指定の更新は以下の形式を有する。

【0050】

【表6】

宛先	距離	タイムスタンプ
4 4 4 4 4 4	0	T820_MH4
1 1 1 1 1 1	3	T516_MH1
2 2 2 2 2 2	1	T238_MH2
3 3 3 3 3 3	2	T674_MH3
5 5 5 5 5 5	2	T502_MH5
6 6 6 6 6 6	1	T186_MH6
7 7 7 7 7 7	2	T238_MH7
8 8 8 8 8 8	3	T160_MH8

【0051】この公示では、移動ホスト4が公示を行っているので、移動ホスト4に関する情報が最初になる。移動ホスト1は、低いアドレスを有するためではなく、影響を及ぼす重要な経路変更を有するただ1つのものなので、移動ホスト1に関する情報が次になる。増分式経路指定の更新全体は、以下のような形式を有する。

【0052】

【表7】

伝送情報　　　　　　「自局アドレス」、距離≡0
層3のプロトコル使用可能度情報が変更された経路
距離が変更された経路

タイムスタンプが変更された経路

【００５３】この例では、層３プロトコル構成を変更した移動ホストはない。１つのコンピュータが新しい位置にあるため、その経路指定情報を変更した。すべてのコンピュータは、新しいタイムスタンプを最新に伝送した。更新されたタイムスタンプが多すぎて単一のパケットに収まらない場合は、収まるタイムスタンプだけが伝送される。これらは、いくつかの増分更新間隔にわたって公平に伝送するために選択される。

【００５４】全経路指定情報パケットの伝送には、そのようなフォーマットは必要でない。必要な数のパケットが使用され、（必要な層３アドレス情報を含めて）使用可能な情報がすべて伝送される。

【００５５】アドホック・ネットワーク・プロトコル内で時間依存性のいくつかの動作を処理するために、標準の事象リスト構造を維持しなければならない。ノードの例は、以下のようでもよい。

【００５６】

【表８】

事象時間
事象識別
事象データ（経路エントリへのポインタ）

【００５７】コンピュータのクロックが刻時するとき、事象リストが検査される。最初のノードが満了した場合、リストと、修正処理手順を呼ぶために使用される識別と、事象処理ルーチンへの引数として引き渡される事象データとから事象ノードが引き出される。

【００５８】以下の説明は、安定待ち待ち時間テーブルに関し、経路指定テーブル・エントリの変動を防ぐ際のその使用法を説明する。経路更新は以下の基準に従って選択されるために、全般的な問題が生じる。

・タイムスタンプがより新しい場合、その経路は常に好ましい。

・そうでなければ、タイムスタンプが同じではあるが距離がより良い（短い）場合に、その経路は好ましい。

問題を理解するために、識別タイムスタンプを有する２つの経路を、間違った順序で移動ホストが受け取ったと仮定する。すなわち、移動ホスト４が、最初により長い距離の次ホップを受け取り、そのすぐ後にタイムスタンプが同じで短い距離の別の次ホップを得ると仮定する。これは、それほど規則的でなく更新を伝送する多数の移動ホストがあるときに起こり得る。その代わりに、移動ホストが著しく異なる伝送間隔でまったく無関係に動作している場合は、それに対応してより少ないホストでこの状況が起こり得る。いずれにせよ、図３において、共通の宛先ＭＨ９に両方とも接続されているが他の移動ホストは共通でない、２つの別々の移動ホスト群中に、この問題を引き起こすのに十分な移動ホストがあると仮定する。さらに、すべての移動ホストは約１５秒毎に更新を伝送しており、移動ホストＭＨ２はＭＨ９まで１２ホップの経路を有し、移動ホストＭＨ６はＭＨ９まで１１ホップの経路を有すると仮定する。さらに、ＭＨ２からの経路指定情報の更新は、ＭＨ６からの経路指定情報の更新よりも約１０秒前にＭＨ４に到着すると仮定する。これは、移動ホストＭＨ９から新しいタイムスタンプが発行されるたびに行われる。実際には、たとえば、新しいタイムスタンプ更新を有するホストが多すぎて全ホストが単一の増分パケットの更新内に収まらないときに起こるように、群IIの任意の移動ホストが複数の増分式更新間隔でそのタイムスタンプ更新を発行し始める場合に、時間差が激烈になり得る。一般に、ホップ数が大きくなるほど、図３における更新配送の差が激烈になると予期される。

【００５９】安定待ち時間データは、最初の２つのフィールドによって指定される、以下の形式を有するテーブルに記憶される。

【００６０】

【表９】

宛先アドレス
次ホップ・アドレス
最終安定待ち時間
平均安定待ち時間

【００６１】新しい経路指定情報の更新が移動ホスト４に達すると仮定する。新しいエントリのタイムスタンプは、今使用したエントリ内のタイムスタンプと同じであり、より新しいエントリはより悪い（すなわち、より長い）距離を有する。そこで、移動ホスト４は、次の転送決定を行う際に新しいエントリを使用しなければならい。ただし、移動ホスト４は、新しい経路を即座に公示する必要はなく、公示する前にどれだけ待つかを決めるためにその経路の安定待ち時間テーブルを調べることができる。この決定のために平均安定待ち時間を使用する。たとえば、経路を公示する前に、移動ホスト４は（平均安定待ち時間＊２）遅延することを決定できる。

【００６２】これは非常に有益なことである。というのは不安定な可能性がある経路が即座に公示されると、その結果がネットワークを介して波及し、移動ホストＭＨ９のタイムスタンプの更新がアドホック・ネットワークを介して波及するたびに、この悪い結果がおそらく繰り返されることになるからである。一方、移動ホストＭＨ６を経由するリンクが本当に壊れた場合は、ＭＨ２を経由する経路の公示をすぐに行うべきである。これを達成するために、移動ホストＭＨ４に変動の履歴があるときは、群II内の中間ホストが問題を発見し、移動ホストＭＨ９までの進路に沿った経路に関して無限の距離を示すトリガされた増分更新を開始するように、十分早くリンク破壊を検出すべきである。すなわち、以前に起こった経路指定更新の変動に類似する問題が現れる場合、その問題は、変動を回避する機構を無力にするのに十分な時間経路更新パターンを支配する他の効果を有するように

思われる。さらに、無限大の距離を有する経路は、定義によりすぐに公示しなければならない。

【００６３】ダンピング機構を最新の事象に有利に片寄らせるために、特定経路の安定待ち時間の最新の測定値を、古い測定値よりも大きな加重因子でカウントしなければならない。そして、重要なことに、経路が真に安定状態とみなされる前にどれだけ安定状態でなければならないかを示すパラメータを選択しなければならない。これは結局、安定待ち時間テーブルにおける１対のアドレス（宛先、次ホップ）の、安定待ち時間の最大値を指定することになる。この最大値を有する経路よりも安定な経路は、それが異なる次ホップまたは距離を有する別の経路で置き換えられる場合と、トリガされた更新を引き起こす。

【００６４】リンク層ソフトウェアが経路指定テーブル管理を実施する方法は周知であるが、説明のために、特定の実施態様について若干の詳細を示す。このテーブル自体は、オペレーティング・システムのデータ・メモリ内に記憶されたデータでしばしばそうであるように、静的に割り振られた固定サイズ・エントリのアレイである。各エントリは「次の」エントリを指定する整数フィールドを有し、これにより通常モードの経路指定テーブルへのアクセスが、線形の探索によるのではなく（静的に大きさが決められたアレイの場合によくあることだが）、リンクしたリストのアクセスのようになる。各宛先ノードは、せいぜい３つ代替経路しか有することができない。これらの経路は、最適経路を最初にして、リストの３つの連続する要素として記憶される。示された最適経路が失敗したり、そのデータが不調と判断された場合は、次の経路が実際に「昇進（ｐｒｏｍｏｔｅｄ）」する。

【００６５】更新がテーブルに適用されるのと同間に「隣接局」から新しい経路指定更新を受け取ったとき、不調のエントリを削除するための処理も行われる。不調のエントリは、最近の二三の更新期間内に更新が適用されなかったエントリと定義される。各隣接局は定期的に更新を送ると期待されるので、しばらく更新を受け取らないと、受信側は対応するコンピュータがもはや隣接局でないと判断することがある。それが起こると、そのコンピュータを実際の（かつては隣接の）宛先として示す経路を含めて、そのコンピュータを次ホップとして使用するどの経路も削除される。エントリが決定される前に発生する更新期間の数が多いと、不調の経路指定エントリの数が増すことになるが、伝送エラーも増す。伝送エラーは、多くの無線実施態様の場合によくあり得ることだが、ＣＳＭＡ型の同報通信媒体を使用するときにも発生する可能性が高い。リンクが壊れたときは、そのリンクおよびそのリンクに依存する経路に対して、無限大の距離の経路をスケジューリングすべきである。

【００６６】図４は、データが不調であると判定されたときのタイム・アウト手順を示す。まず機能ブロック４０で、事象リスト・データから経路エントリが得られ、ついで機能ブロック４１で、内部テーブルから経路が削除される。機能ブロック４２で、公示される経路のテーブルに無限大の距離が挿入され、次に判断ブロック４３で、その宛先が他の宛先の次ホップかどうかを判定する試験が行われる。そうである場合は、機能ブロック４４で、現在到達不可能な宛先に対して無限大の距離の経路が公示される。図５に示したように、"ＡＤＶＥＲＴＩＳＥ"事象処理は、機能ブロック４５で公示された経路リストに指定された経路を挿入する処理と、次いで機能ブロック４６でＩＮＣＲＥＭＥＮＴＡＬフラグをセットする処理とを含む。同時に、ＳＨＯＷＮ　ＹＥＴフラグがリセットされる。挿入される経路は、宛先まで無限大の距離を示すことになる。

【００６７】図６は、移動ホストからの増分式更新伝送の論理を示す。この処理は、機能ブロック４７から始まり、プロトコル使用可能度の変化が挿入される。次いで、機能ブロック４８で公示経路リストが走査され、判断ブロック４９でＦＬＡＧＳおよびＳＨＯＷＮ　ＹＥＴが０であるか検査が行われる。この条件に合えば、機能ブロック５０で、その経路が挿入され、フラグがセットされる。次に、判断ブロック５１で試験が行われ、出力パケットが一杯過ぎないかどうか判定する。一杯過ぎる場合は、処理が終わる前に、機能ブロック５２で全ダンプがスケジューリングされ、そうでない場合は、機能ブロック４８に戻って公示経路リストを走査する。

【００６８】公示経路リストが走査されるとも、判断ブロック５３で試験が行われ、ＦＬＡＧＳとＩＮＣＲＥＭＥＮＴＡＬが０でないかどうか判定する。０である場合は、処理は機能ブロック４８に戻り、そうでない場合は、機能ブロック５４でその経路が挿入される。判断ブロック５５で試験が行われ、出力パケートが一杯過ぎないかどうか判定する。一杯過ぎる場合は、機能ブロック５２で全ダンプがスケジューリングされ、そうでない場合は、機能ブロック５６で公示経路リストが再び走査されるが、このときはＬＡＳＴ　ＡＤＶ　ＴＩＭＥＳＴＡＭＰから始まる。公示経路リストが走査されるとき、判断ブロック５７で試験が行われ、ＦＬＡＧＳおよびＮＥＷ　ＴＩＭＥＳＴＡＭＰが０でないかどうか判定する。０でない場合は、機能ブロック５８で経路が挿入され、判断ブロック５９で試験が行われ、出力パケットが一杯過ぎないかどうかを判定する。一杯過ぎる場合は、機能ブロック６０でＬＡＳＴ　ＡＤＶ　ＴＩＭＥＳＴＡＭＰが提示された最後の経路にセットされ、そうでない場合は、機能ブロック６１でＬＡＳＴ　ＡＤＶ　ＴＩＭＥＳＴＡＭＰがゼロにセットされ、処理が終了する。

【００６９】図７は、移動ホストからの全ダンプ伝送の論理を示す。まず、判断ブロック６２で試験が行われ、またどの経路も示されていないかどうかを判定する。示

されていない場合は、処理が終わる前に機能ブロック６３で、増分伝送が行われ、全ダンプが再びスケジューリングされる。そうでない場合は、機能ブロック６４で、指定されたテーブル・フォーマットに従って使用可能なプロトコルがすべて挿入される。次に、機能ブロック６５で、テーブルの形式に従って、公示経路がすべて挿入される"ＦＬＡＧＳ"フィールドが削除される。最後に、機能ブロック６６で、すべての公示経路で増分がリセットされ、処理が終了する。

【００７０】図８は、受信時の全ダンプ処理の論理を示す。まず機能ブロック６７で入力データが走査され、判断ブロック６８でタイムスタンプが新しいかどうか、判断ブロック６９で経路が新しいかあるいは新しい距離を有するかどうか、また判断ブロック７０でどれかのプロトコルが変更されたかどうかを判定する。タイムスタンプが新しい場合は、機能ブロック７１で、内部経路指定テーブルに現行値が置かれ、タイムアウト事象が再びスケジューリングされて、テーブル内で新しいタイムアウトがマークされる。次に、機能ブロック７２で、その経路の安定待ち時間の測定を開始し、処理が終了する。一方、経路が新しいかあるいは新しい距離を有する場合は、機能ブロック７３で、エラー・アクティビティがスケジューリングされる。次いで、機能ブロック７４で、安定待ち時間が更新され、処理が終了する。一方、どれかのプロトコルが変化した場合は、機能ブロック７５でたとえばＡＲＰテーブル管理を使って、適切な層３アクティビティが変更される。

【００７１】図９は、受信時の増分式更新処理を示す。機能ブロック７６で入力データが走査され、判断ブロック７７でプロトコル使用可能度が変更されたかどうか、判断ブロック７８で経路が新しいかどうか、判断ブロック７９でタイムスタンプが古いかどうか、判断ブロック８０でタイムスタンプが同じで距離がより短いかどうかを判定する。プロトコル使用可能度が変化している場合は、機能ブロック８１で適切な層３処理ルーチンを呼び出し、判断ブロック７８に進む。経路が新しい場合は、機能ブロック８２で出力増分更新がスケジューリングされ、処理が終了する。タイムスタンプが古い場合は、判断ブロック８３でさらに試験が行われ、経路が無限大の距離を有するかどうか判定する。経路が無限大の距離を持たない場合は、機能ブロック８４で破棄され、処理が終了する。経路が無限大の距離を有する場合は、機能ブロック８５でＳＨＯＷＮ　ＹＥＴフラグがリセットされ、処理が終了する。タイムスタンプが同じで距離がより短い場合、機能ブロック８６で現安定待ち時間が更新され、機能ブロック８７で公示リストに新しいエントリが最初に入れられる。次に、機能ブロック８８で、ＳＨＯＷＮ　ＹＥＴフラグがリセットされ、増分がセットさ＊＊れ、関係する"ＡＤＶＥＲＴＩＳＥ"事象が削除され、処理が終了する。判断ブロック８０に戻り、結果が否定の場合は機能ブロック８９に進み、内部テーブル内の経路エントリが使用され、タイムアウトがリセットされる。次に、機能ブロック９０で、安定待ち時間の現行評価後、覚醒がスケジューリングされ、処理が終了する。

【００７２】図１０は、安定待ち時間が過ぎた後に、経路を公示経路に挿入するための流れ図を示す。この処理は、図９の機能ブロック９０でセットされた覚醒タイマが、機能ブロック１０１で鳴ると始まる。これが起こると、判断ブロック１０２で試験が行われて、確立された経路が公示された経路と同じであるかどうかを判定する。同じ場合は、何も行う必要はなく、処理は終了する。しかし異なる場合は、機能ブロック１０３でＳＨＯＷＮ　ＹＥＴがリセットされ、処理が終わる前に、機能ブロック１０４で次の増分更新がスケジューリングされる。

【００７３】上記以外にも、関与する各コンピュータ（移動局または基地局）によって同報通信される経路指定テーブル内の各エントリの一部分として伝送される追加のデータ・フィールドがある。これらのフィールドは、たとえば、高水準のプロトコルまたはリンク層の動作に依存する他のプロトコルによって決まる。たとえば、正しいＡＲＰ動作を可能にするために、各経路指定テーブル・エントリが、宛先アドレスに対応するインターネット・プロトコル（ＩＰ）アドレスも含まなければならないこともある。これは、隣接局のために経路指定機能を利用するときに、中間のコンピュータを使用可能にするために行われ、ＡＲＰ同報通信の経路指定の代わりに「代理ＡＲＰ」も発行する。

【００７４】協力する移動ホスト間でアドホック・ネットワークを達成するために使用される、様々な手順を記述する疑似Ｃコードを以下にリストする。

【００７５】

```
struct forwarding route entry{
 address t destination;

 address t next hop;
 value t metric;
 value t settling time;
 value t install time;
 protocol list;
 flags;
}
/*
```

このテーブルは、これらの手順を実行する移動ホストに関するデータを常に含むように初期設定する。

```
*/
struct advertised route entry{
```

```
address t destination;
value t metric;
proto ptr protocol list;
struct advertised route entry
  *advertised route table={myaddress, 0,my protocol list};
struct protocol list{
 value t protocol type;
 value t address size;
 u char[] layer 3 address;
}
/*
*各移動ホストは、経路エントリの２つのテーブルを維持しなければならない。
*－公示される経路エントリ
*－転送用に使われる経路
*/
/*
*各移動ホストは、可能な各種のタイムアウト事象に関してノードを有する事象リ
*ストを維持しなければならない。可能な事象は以下のとおりである。
*－経路指定テーブル・エントリをタイムアウトする
*－起こり得る変動を回避するためにその公示が遅延された公示テーブルへの経路
*  を加える。
*－公示を周期的に同報通信する（増分式または全）。
*/
Timeout()
{
 get event from list();
 switch (event type)
 case ROUTE TIMEOUT:
   bad route=event type->route;
   if (bad route->metric =1) /* おっと、隣接局が死んだ*/
     for (route = first; /*テーブル内のすべての経路について*/){
       if route->next hop = bad route){
         rOute->metric = INFINITE METRIC;
         route->flags  = METRIC CHANGED;
         route->timestamp | =1;
     }
   }
   bad route->flags l=METRIC CHANGED
   bad route->metric=INFINITE METRIC;
   bad route->timestampl=1; /*  １だけ増分した*/
   do incremntal();
   break;
 case ADD ADVERTISEMENT:
    route->flags l=CHANGED;
    break;
 case DO ADVERTISEMENT:
    if (full dump scheduled)
      do full dump();
```

```
    else
      do incremental();
    break;
  }
}
struct settling time table{
  address t destination;
  time t settling time;
  value t number of next hops;
  addr list next hop list;
}
struct next hop list{
  address t next hop;
  list ptr *next hop list;
}
do full dump()
{
  get empty NPDU();
  for (/*公示された経路指定テーブル内の各経路*/)
    {
    copy route into NPDU()
    if (NPDU full) (
       transmit NPDU();
       get empty NPDU();
    }
    route->flags &= /*変更ビットをリセットする*/
      NOT(CHANGED 1 CHANGED PROTOCOL 1
        CHANGED METRIC);
    }
    /*上記で自局データが自動的に含まれたことに留意されたい*/
    schedule full dump(USUAL PERIOD);
}
/*
*増分ダンプは、次のようないくつかの部分に集積する。
*－送信局（すなわち、この移動ホスト）に関するエントリ。
*－新しい移動ホストまたは層３プロトコル使用可能度情報を修正した移動ホス
ト
*  に関するエントリ。
*－経路指定情報が実質上変更された新しい移動ホストに関するエントリ。
*－新しいタイムスタンプだけを反映しているエントリ。
*増分パケットは、１つの層３パケット（ネットワーク・プロトコル・データ・
ユ
*ニット）だけに収まるように制約される。重要な変化が多すぎて報告できない
場
*合は、全ダンプをスケジューリングしなければならない。タイムスタンプ更新
が
*多すぎて報告できない場合は、最後に報告されたタイムスタンプ更新を追跡し
、
*次回はそれからスタートする。
*/
```

```
do incremental dump()
{
  get empty NPDU();
  /*最初に自局の新しいタイムスタンプを伝送する。距離０*/
  if (route to myself->timestamp & 0x00000001 !=0)
    printf ("予期しない内部タイムスタンプ error\r\n");
  route to myself->timestamp = route to myself +2;
  copy route into NPDU(route to myself)
  for ( route=first;/*公示経路指定テーブル内の各経路*/)
    if (route->flags & PROTOCOL CHANGED)
      copy route into NPDU(route)
    if (NPDU full) (
      schedule full dump(IMMEDIATE);
      printf (Unexpectedly full incremental!¥n");
      transmit NPDU();
      get empty NPDU();
    }
  }
  for ( route=first; /*公示経路指定テーブル内の各経路*/) {
   if (route->flags & ALREADY DONE) continue;
      /*上記でこれはすでに示された*/
    if (route->flags & METRIC CHANGED)
      copy route into NPDU(route)
    if (NPDU full) (
      schedule full dump(IMMEDIATE);
      printf ("予期せず全増分incremental!\n");
      transmit NPDU();
      get empty NPDU();
    }
  }
  for (route=last timestamp shown; /* */) {
    if (route->flags & ALREADY DONE) continue;
       /*上記でこれはすでに示された*/
    if (route->flags & TIMESTAMP CHANGED) {
      copy route into NPDU(route)
      last timestamp shown = route;
    }
    if (NPDU full) (
      break; /*増分パケットの構築を停止する*/
    }
  }
  transmit NPDU();
}
/*
*移動ホストが隣接局のうちの１つから経路指定情報を受け取ると、パケットの
各
*経路エントリを調べて、その内部経路指定テーブルを更新するかどうかを決定
す
*る。入力パケットが全ダンプである場合は、通常、実質上異なる情報は期待さ
れ
```

*ない。より新しい場合あるいは新しさは同等だがより短い距離を有する場合に
、
*新しい経路が受け入れられる。
*
*入力経路がより新しいタイムスタンプという基準に基づいて受け入れられる場
合
*、新しい経路を公示するかどうか決定を行う。この決定は、特定の宛先移動ホ
ス
*トに関してパケットの送信側（すなわち、次ホップ）から得た経路の過去の履
歴
*に依存する。
*
*次ホップを通る経路が次ホップまでの経路よりも（この移動ホストから次ホッ
プ
*までのホップなので）１ホップだけ長くなることを反映するために、任意の入
力
*経路に関して示された距離を１だけ増分しなければならないことに留意された
い
*。
*/

```
process incoming route update()
{
  must schedule incremental = FALSE;
  for (new route=packet data; /*パケット内の各エントリを行う*/{
      old route = find(new route,route table);
      new route->metric =new route->metric +1;
      if (new route->timestamp >
         old route->timestamp) {
         new route->timeout =
           calculate timeout(new route);
         replace (old routej new route);
           route table);
         delete timeout event (old route);
         schedule timeout event (new route);
         if (new route->type & CHANGED PROTOCOL){
           must schedule incremental = TRUE;
           new route->flags l=CHANGED PROTOCOL;
           new route->install time =
              current time();
         }
         else if ((new route->type &
           CHANGED METRIC)  ll
           (new route->metric < old route->metric {
         must schedule incremental = TRUE;
           new route->flags l=CHANGED METRIC;
           new route->install time =current time();
         }
         else if (new route->metric >=
           old route->metric) {
           stable time = check settling time
```

```
        (new route)
      if (0 ==stable time) /*それを公示する*/
        new route->flags l= CHANGED;
      else
        enter event list(new route,
          stable time,ADD ADVERTISEMENT);
      }
    }
    else if ((new route->timestamp ==
      old route->timestamp) &&
      (new route->metric < old route->metric)) {
      enter settling time data (old route,
        new route);
      new route->timeout =
        calculate timeout(new route);
      replace (old route, new route,
        route table);
      delete timeout event (old route);
      schedule timeout event (new route);
      new route->flags l=CHANGED METRIC;
      new route->install time = current time();
    }
  }
  if (must schedule incremental) {
    schedule incremental(IMMEDIATE);
  if (incoming packet->packet type ==FULL DUMP)
    printf ("Full dump has new,unreported
      data!¥r¥n");
  }
}
/*
*変動を弱めるために、経路変化の頻度に関するデータを保持する。ある状況では
*、同じタイムスタンプを有する特定の移動ホストで経路公示を受け取るが、「順
*序外れ」で受け取る、すなわち同じタイムスタンプを有する２つの経路がより短
*い距離に最初に達することが考えられる。
*  最終安定待ち時間
*  平均安定待ち時間
*２つのデータが保持される。
*平均安定待ち時間は、前の平均を１６倍し、現行値を２倍し、それらの結果を加
*えて１８で割って計算される。これは、前の１６個の結果よりも最新の結果に少
*し大きな重みを与える効果がある。
*/
enter settling time (new route, old route)
{
  route data = find (new route->destination,
```

```
    old route->next hop, settling time table);
  settling time = (16*
    route data->settling time) +
    2* (current time() - old route->install time);
  settling time = settling time ¥ 18;
}
check settling time (new route)
{
  route data = find (new route,
    settling time table);
  settling time data =route data->settling time;
  if (settling time data == NULL) return 0;
  if (settling time data > MAXIMUM DELAY) return 0;
  else return (settling time data);
```

【００７６】本発明を１つの好ましい実施例に基づいて説明したが、添付の特許請求の範囲の趣旨および範囲内で本発明を修正して実施できることが、当業者には理解されよう。本発明の新しい経路指定アルゴリズムは、特に、移動コンピュータの動作に最も劇的に必要とされる「アドホック・ネットワーク」の作成を可能にするために開発されたものである。しかし、この経路指定アルゴリズム自体、および「アドホック・ネットワーク」の動作は、移動コンピュータを含まない状況でも有利に使用することができる。たとえば、この経路指定アルゴリズムは、（リンク状態経路指定アルゴリズムに比べて）少ないメモリ要件を必要とする状況に適用することができる。「アドホック・ネットワーク」の動作は、無線移動コンピュータだけでなく有線移動コンピュータにも適用できる。したがって、一般に、本発明は、新しい宛先順経路指定アルゴリズムを提供し、このアルゴリズムは変動を弱める技法によって補われる。

【００７７】まとめとして、本発明の構成に関して以下の事項を開示する。

【００７８】（１）それぞれ固有ネットワーク・アドレスを持つが固定位置を持たない複数の移動ホストから構成されるアドホック・ネットワークに結合された２つの移動ホスト間で、パケットの情報を経路指定する方法であって、各移動ホストにおいて、ソース移動ホストから宛先移動ホストまでのホップ数として定義された「距離」を含む経路指定テーブルを記憶する段階と、各移動ホストに記憶された経路指定テーブルを、その移動ホストが周期的に同報通信することにより経路を公示する段階と、宛先移動ホストから発したタイムスタンプで、各経路指定テーブルのエントリをタグ付けする段階と、他の移動ホストから受け取った同報通信に基づいて、各宛先移動ホストごとに、移動ホストに記憶された経路指定テーブルを更新する段階と、各移動ホストが、隣接移動ホストから受け取った新しい経路指定情報を再伝送する段階と、所望の宛先移動ホストに関する最良の「距離」を有する経路として、ソース移動ホストからパケットの情報を伝送するための経路を選択する段階とを含む方法。

（２）アドホック・ネットワークが、ネットワーク層とリンク層とを含むネットワーク規格に従い、経路指定がアドホック・ネットワークのリンク層で実行されることを特徴とする、上記（１）に記載の経路指定方法。

（３）新しい経路が、より短い距離または無限の距離を有する経路と定義され、無限の距離は、破壊されたリンクを表し、すなわち特定の宛先が到達可能でなくなり、したがってこの新規の到達不可能な宛先に依存する他のすべての宛先がそれ自体到達不可能になることを意味し、隣接移動ホストから受け取った新しい経路指定情報を再伝送する前記段階が、新しい経路指定情報の受信時に移動ホストによって即時実行されることを特徴とする、上記（１）に記載の経路指定方法。

（４）前記経路指定テーブルに記憶された経路が変化する頻度に関するデータを保持する段階と、前記経路指定テーブルに記憶された経路の平均安定待ち時間を決定することによって、経路の安定性を測定する段階と、測定された経路の安定待ち時間を安定待ち時間テーブルに、記憶する段階と、公示段階の前に安定待ち時間テーブルにアクセスし、まもなく変化する可能性のある経路の公示を遅らせ、それにより前記経路指定テーブル内の情報の変動を弱める段階とをさらに含む、上記（１）に記載の経路指定方法。

（５）古い測定値よりも大きな加重因子を有する特定の経路の安定待ち時間の最新の測定値をカウントすることにより、測定された経路安定待ち時間に重み付けを行う段階をさらに含む、上記（４）に記載の経路指定方法。

（６）アドホック・ネットワークがさらに、移動ホストのネットワーク層アドレスに基づいて、前記経路指定テーブルに経路指定情報を記憶する段階と、前記経路指定テーブルに記憶された経路が変化する頻度に関するデータを保持する段階と、前記経路指定テーブルに記憶された経路の平均安定待ち時間を決定することにより、経路の安定性を測定する段階と、測定された経路の安定待ち

時間を安定待ち時間テーブルに記憶する段階と、公示段階の前に安定待ち時間テーブルにアクセスし、まもなく変化する可能性のある経路の公示を遅らせ、それにより前記経路指定テーブル内の情報の変動を弱める段階とをさらに含む、上記（１）に記載の経路指定方法。

（７）移動ホストのリンク層アドレスに基づいて、前記経路指定テーブルに経路指定情報を記憶する段階と、前記経路指定テーブルに記憶された経路が変化する頻度に関するデータを保持する段階と、前記経路指定テーブルに記憶された経路の平均安定待ち時間を決定することにより、経路の安定性を測定する段階と、測定された経路の安定待ち時間を安定待ち時間テーブルに記憶する段階と、公示段階の前に安定待ち時間テーブルにアクセスし、まもなく変化する可能性のある経路の公示を遅らせ、それにより前記経路指定テーブル内の情報の変動を弱める段階とをさらに含む、上記（１）に記載の経路指定方法。

（８）ネットワーク層プロトコル使用可能度データを宛先ごとに追跡する段階をさらに含む、上記（１）に記載の経路指定方法。

（９）それぞれ固有ネットワーク・アドレスを持つが固定位置をもたない複数の移動ホストから構成され、ネットワーク層とリンク層とを含み、ネットワーク規格に従うアドホック・ネットワークに結合された２つの移動ホスト間で、パケットの情報を経路指定する方法であって、各移動ホストにおいて、ソース移動ホストから宛先移動ホストまでのホップ数として定義された「距離」を含む経路指定テーブルを記憶する段階と、各移動ホストに記憶された経路指定テーブルを、その移動ホストが周期的に同報通信することにより経路を公示する段階と、宛先移動ホストから発したタイムスタンプで、各経路指定テーブルのエントリをタグ付けする段階と、他の移動ホストから受け取った同報通信に基づき、移動ホストに記憶された経路指定テーブルを移動ホストごとに更新する段階であって、前記更新が、より良い距離または無限の距離を有する経路と定義される新しい経路に限定され、無限の距離が破壊リンクを表し、すなわち、特定の宛先が到達可能でなくなり、したがってこの新規の到達不可能な宛先に依存する他のすべての宛先がそれ自体到達不可能になることを意味する更新段階と、隣接移動ホストから受け取った新しい経路指定情報を各移動ホストが再伝送する段階であって、移動ホストが新しい経路指定情報を受け取ると即時に実行される再伝送段階と、所望の宛先移動ホストに関する最短の「距離」を有する経路として、ソース移動ホストからパケットの情報を伝送する経路を選択する段階とを含む方法。

（１０）前記経路指定テーブルに記憶された経路が変化する頻度に関するデータを保持する段階と、前記経路指定テーブルに記憶された経路の平均安定待ち時間を決定することにより、経路の安定性を測定する段階と、測定した経路の安定待ち時間を安定待ち時間テーブルに記憶する段階と、公示段階の前に安定待ち時間テーブルにアクセスし、まもなく変化する可能性のある経路の公示を遅らせ、それにより前記経路指定テーブル内の情報の変動を弱める段階とを含む、上記（９）に記載の経路指定方法。

（１１）古い事象よりも大きな加重因子を有する特定経路の安定待ち時間の最新の測定値をカウントすることによって、測定された経路安定待ち時間に重み付けを行う段階をさらに含む、上記（１０）に記載の経路指定方法。

【発明の効果】変化する任意の相互接続経路に沿って任意の時点でデータを交換できる移動コンピュータ群が、そのコンピュータに、データを変換できる経路を与えることができる、データ通信システムを提供できる。

【図面の簡単な説明】

【図１】国防データ・ネットワークのアーキテクチャ図である。

【図２】複数の無線移動ホストからなる「アドホック」ネットワークの機能ブロック図である。

【図３】共通の宛先に接続された、２つの別々の移動ホスト群を示す機能ブロック図である。

【図４】タイムアウト手順の論理を示す流れ図である。

【図５】"ＡＤＶＥＲＴＩＳＥ"事象処理の論理を示す流れ図である。

【図６】増分式更新伝送の論理を示す流れ図である。

【図７】全ダンプ伝送の論理を示す流れ図である。

【図８】受信時の全ダンプ処理の論理を示す流れ図である。

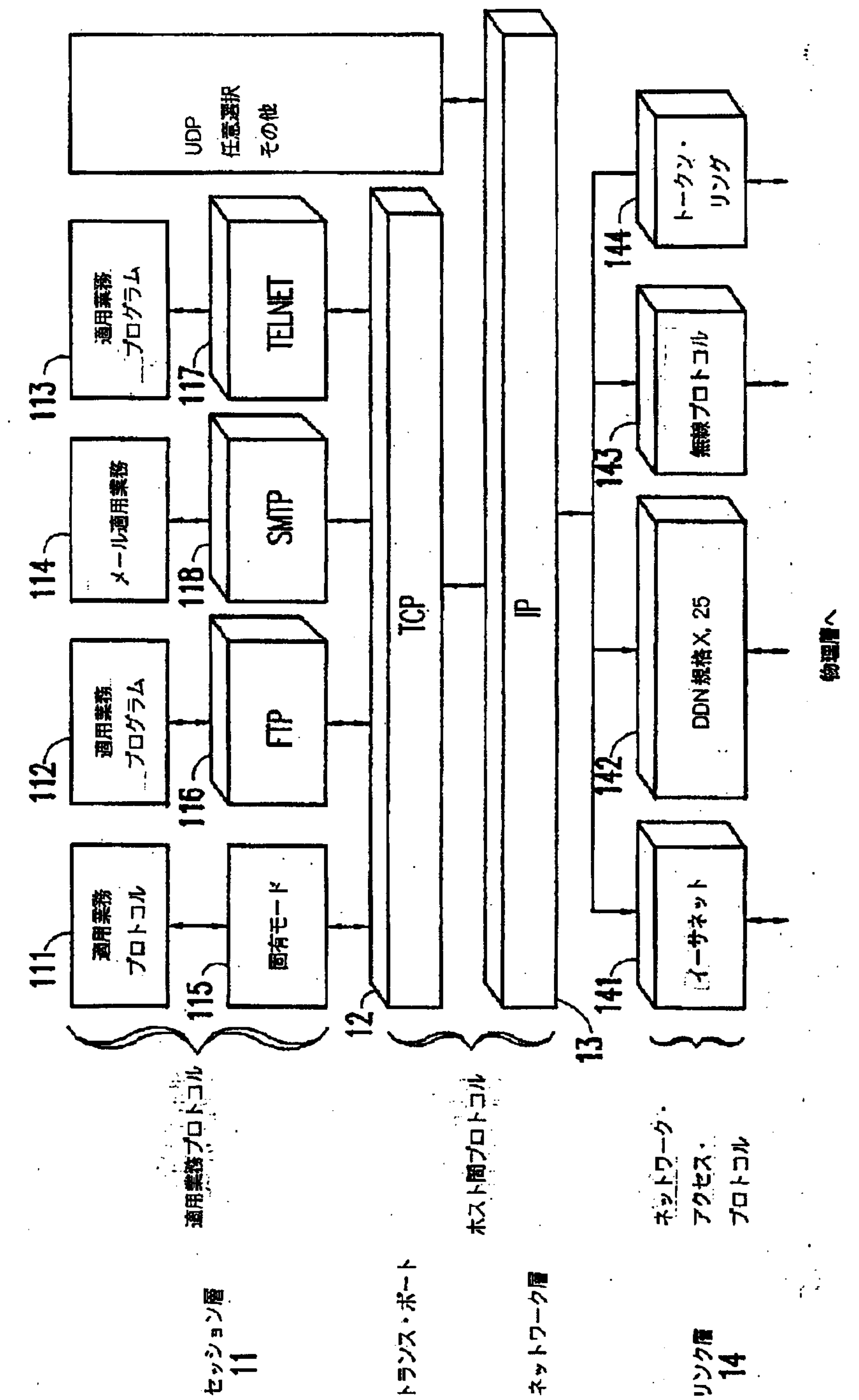
【図９】受信時の増分式更新処理の論理を示す流れ図である。

【図１０】安定待ち時間の経過後に、公示経路に経路を挿入する論理を示す流れ図である。

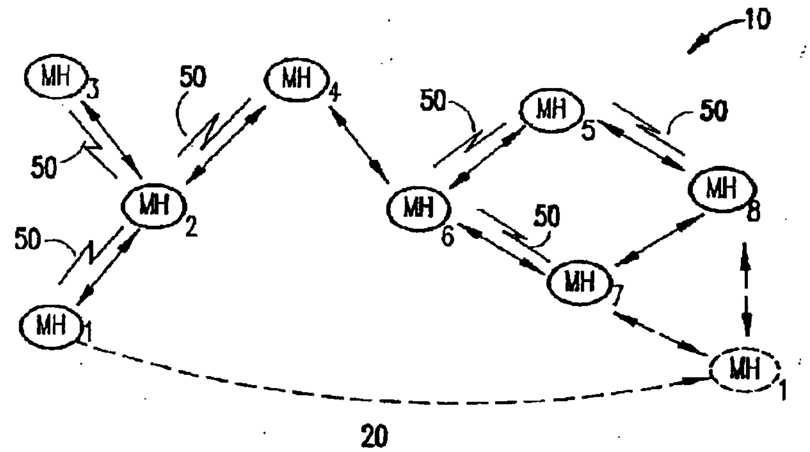
【符号の説明】

１　移動ホスト
２　移動ホスト
３　移動ホスト
４　移動ホスト
５　移動ホスト
６　移動ホスト
７　移動ホスト
８　移動ホスト
１０　アドホック・ネットワーク
５０　双方向無線リンク

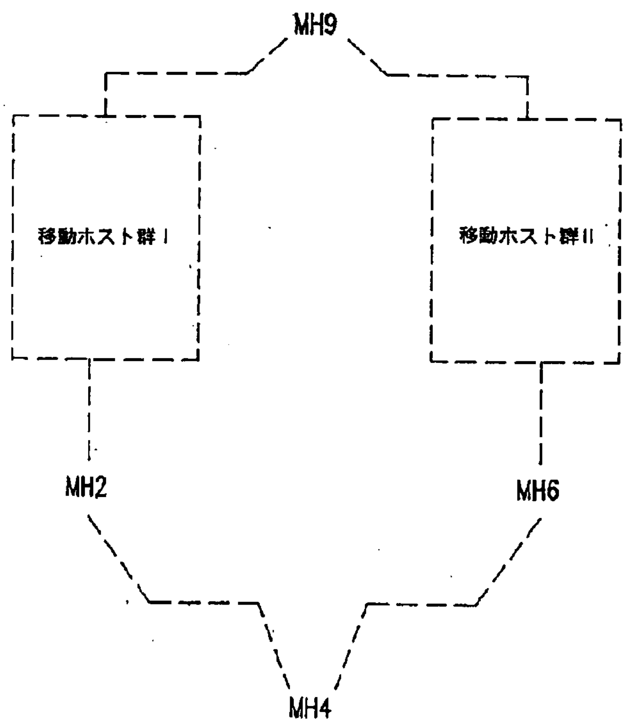
【図1】


UDP
任意選択
その他
適用業務プロトコル
固有モード
適用業務プログラム
FTP
メール適用業務
SMTP
TELNET
TCP
IP
イーサネット
DDN規格X, 25
無線プロトコル
トークン・リング
物理層へ
適用業務プロトコル
ホスト間プロトコル
ネットワーク・アクセス・プロトコル
セッション層
11
トランス・ポート
ネットワーク層
リンク層
14
111
112
113
114
115
116
117
118
12
13
141
142
143
144

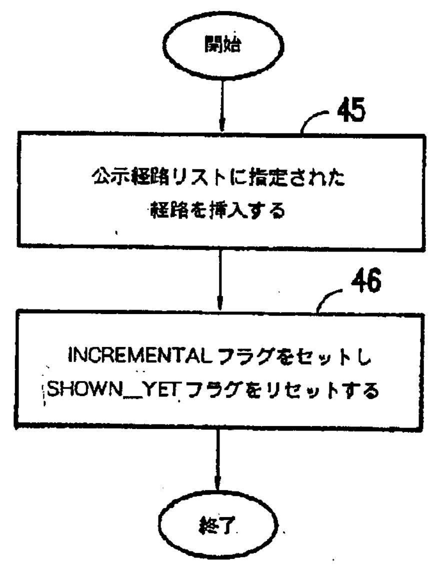
【図２】


10
MH 3
MH 4
MH 5
MH 8
MH 2
MH 6
MH 7
MH 1
MH 1
50
50
50
50
50
50
20

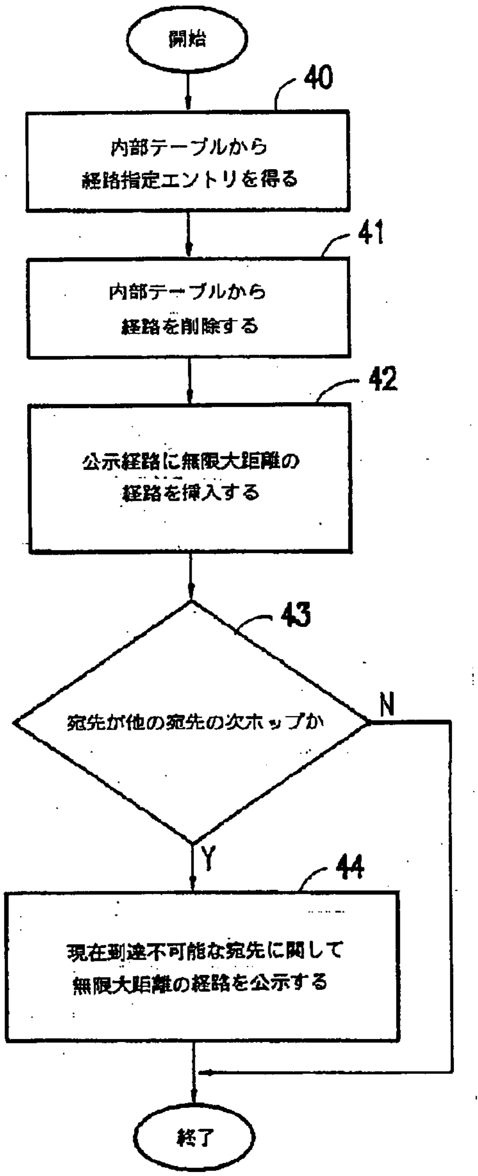
【図３】


MH9
移動ホスト群 I
移動ホスト群 II
MH2
MH6
MH4

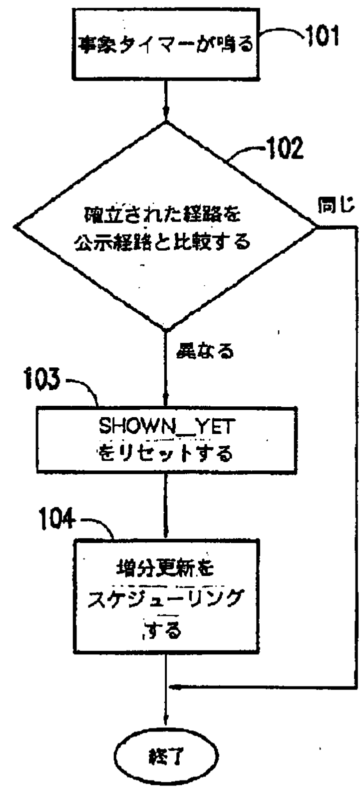
【図５】


開始
45
公示経路リストに指定された
経路を挿入する
46
INCREMENTAL フラグをセットし
SHOWN__YET フラグをリセットする
終了

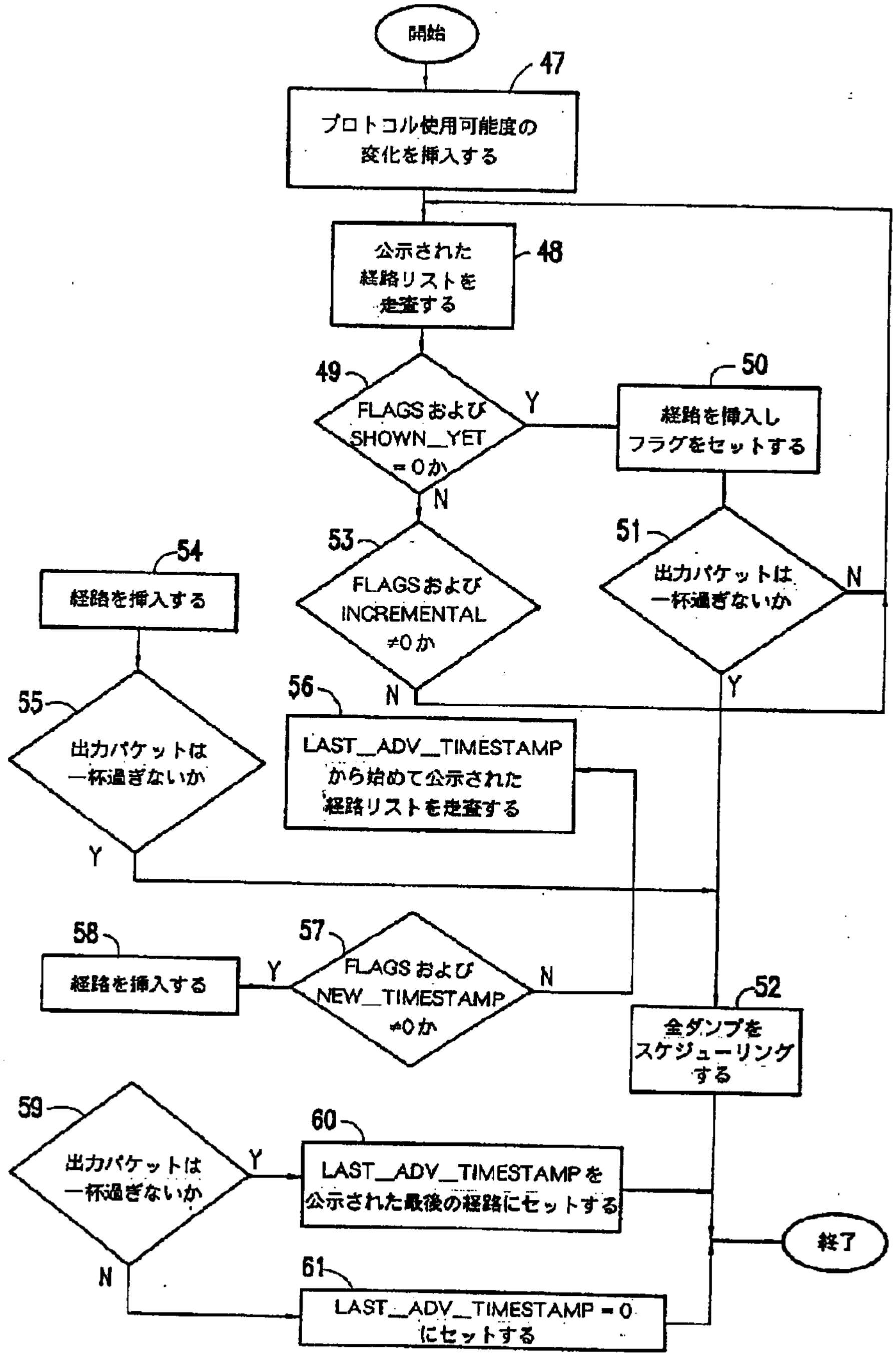
【図４】


開始
40
内部テーブルから
経路指定エントリを得る
41
内部テーブルから
経路を削除する
42
公示経路に無限大距離の
経路を挿入する
43
宛先が他の宛先の次ホップか
N
Y
44
現在到達不可能な宛先に関して
無限大距離の経路を公示する
終了

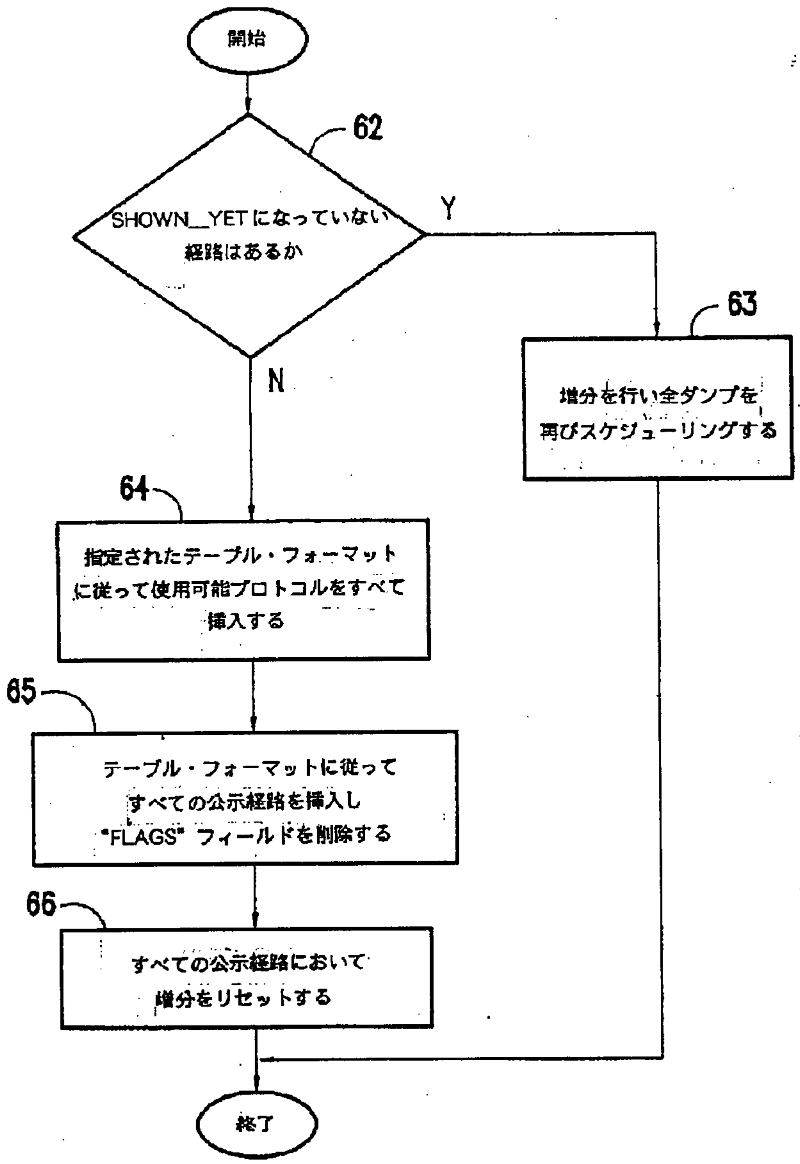
【図１０】


事象タイマーが鳴る
101
102
確立された経路を
公示経路と比較する
同じ
異なる
103
SHOWN_YET
をリセットする
104
増分更新を
スケジューリング
する
終了

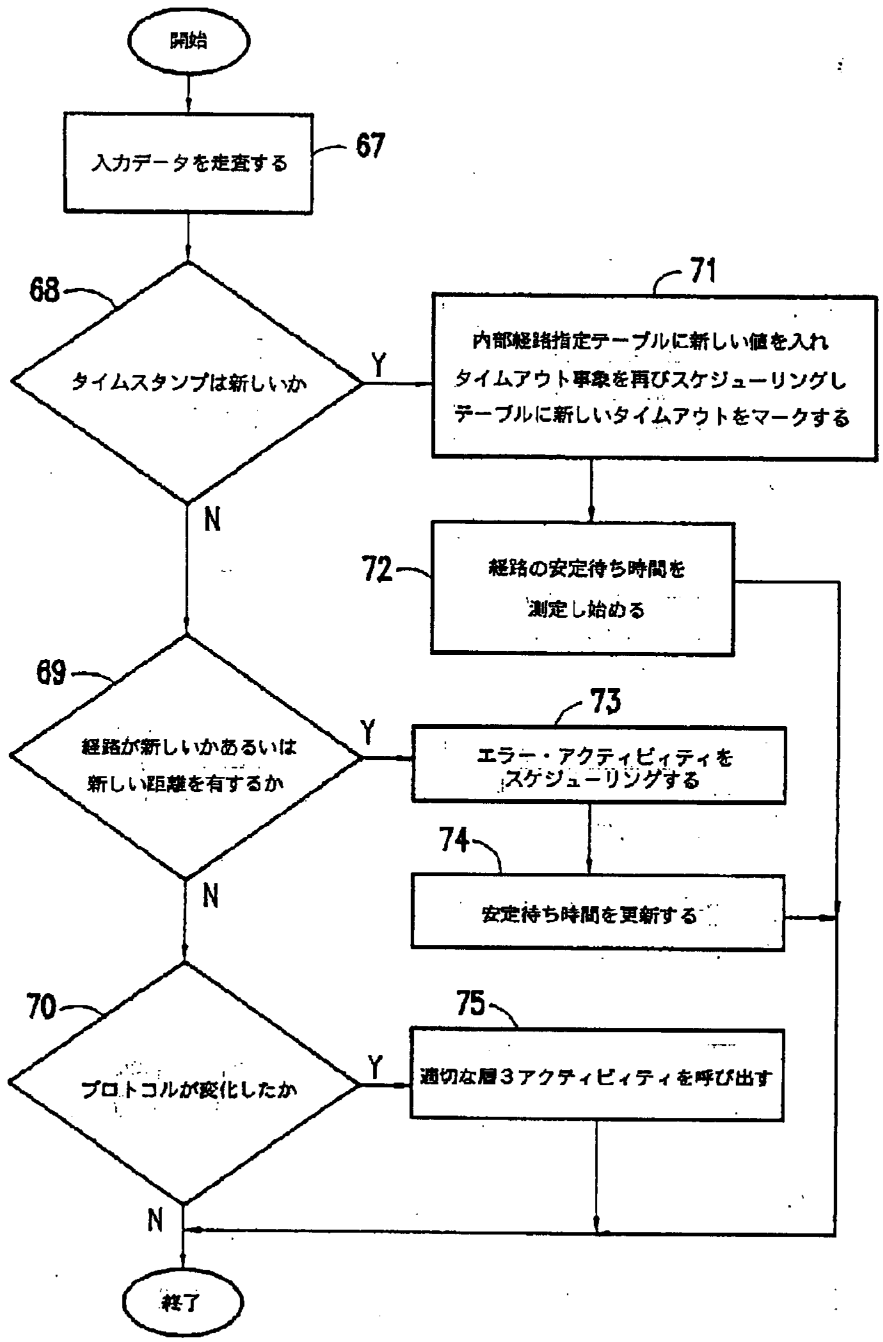
【図６】


開始
47
プロトコル使用可能度の変化を挿入する
48
公示された経路リストを走査する
49
FLAGSおよびSHOWN__YET≠0か
Y
N
50
経路を挿入しフラグをセットする
51
出力パケットは一杯過ぎないか
N
Y
53
FLAGSおよびINCREMENTAL≠0か
N
54
経路を挿入する
55
出力パケットは一杯過ぎないか
Y
56
LAST__ADV__TIMESTAMPから始めて公示された経路リストを走査する
57
FLAGSおよびNEW__TIMESTAMP≠0か
Y
N
58
経路を挿入する
52
全ダンプをスケジューリングする
59
出力パケットは一杯過ぎないか
Y
N
60
LAST__ADV__TIMESTAMPを公示された最後の経路にセットする
61
LAST__ADV__TIMESTAMP＝0にセットする
終了

【図７】

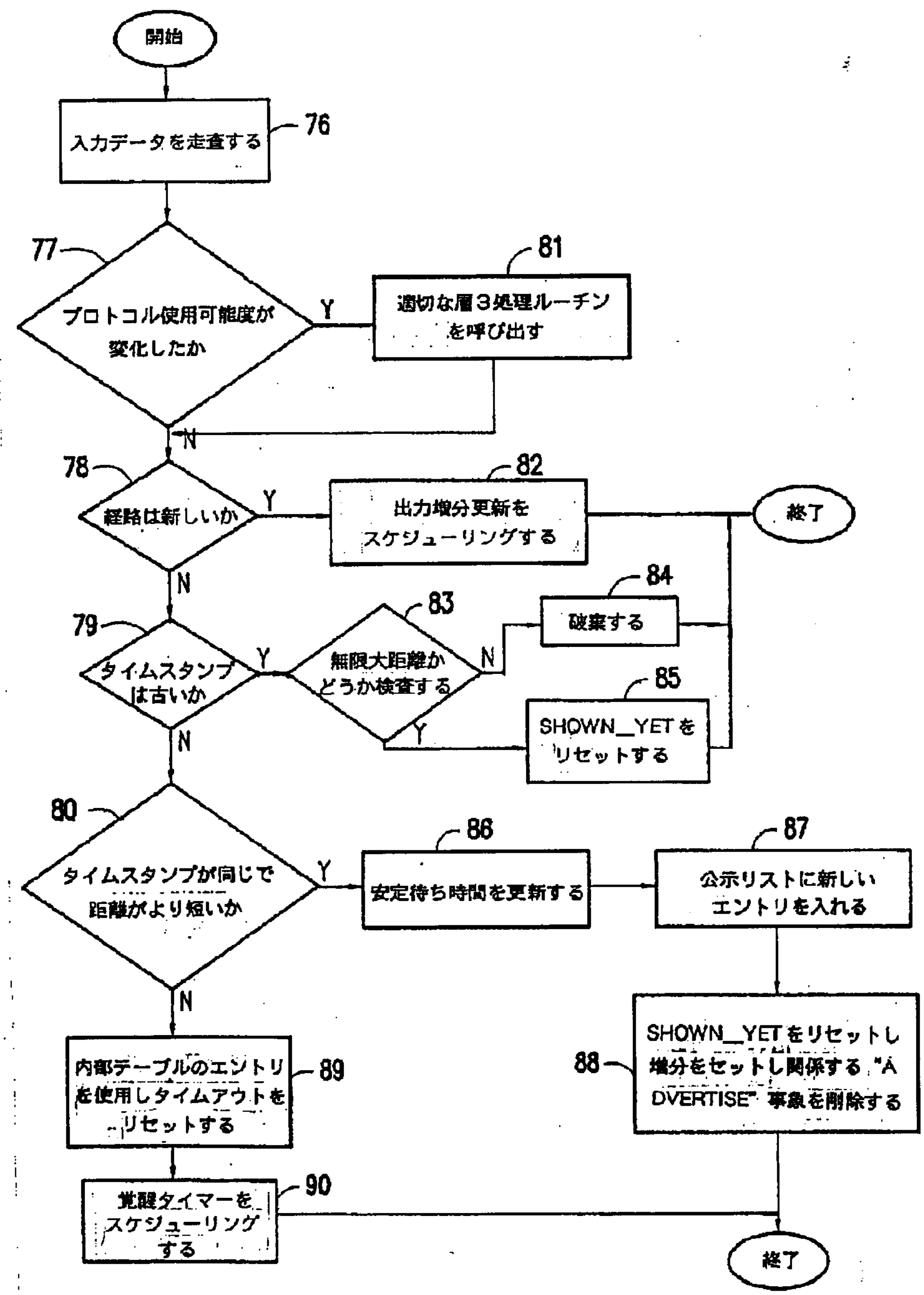

開始
62
SHOWN__YETになっていない
経路はあるか
Y
N
63
増分を行い全ダンプを
再びスケジューリングする
64
指定されたテーブル・フォーマット
に従って使用可能プロトコルをすべて
挿入する
65
テーブル・フォーマットに従って
すべての公示経路を挿入し
"FLAGS" フィールドを削除する
66
すべての公示経路において
増分をリセットする
終了

【図８】



開始
入力データを走査する
67
68
タイムスタンプは新しいか
Y
71
内部経路指定テーブルに新しい値を入れ
タイムアウト事象を再びスケジューリングし
テーブルに新しいタイムアウトをマークする
N
72
経路の安定待ち時間を
測定し始める
69
経路が新しいかあるいは
新しい距離を有するか
Y
73
エラー・アクティビィティを
スケジューリングする
74
安定待ち時間を更新する
N
70
75
プロトコルが変化したか
Y
適切な層３アクティビィティを呼び出す
N
終了

【図９】


開始
入力データを走査する
76
77
プロトコル使用可能度が変化したか
Y
81
適切な層３処理ルーチンを呼び出す
N
78
経路は新しいか
Y
82
出力増分更新をスケジューリングする
終了
N
79
タイムスタンプは古いか
Y
83
無限大距離かどうか検査する
N
84
破棄する
Y
85
SHOWN__YETをリセットする
N
80
タイムスタンプが同じで距離がより短いか
Y
86
安定待ち時間を更新する
87
公示リストに新しいエントリを入れる
N
89
内部テーブルのエントリを使用しタイムアウトをリセットする
88
SHOWN__YETをリセットし増分をセットし関係する"ADVERTISE"事象を削除する
90
覚醒タイマーをスケジューリングする
終了